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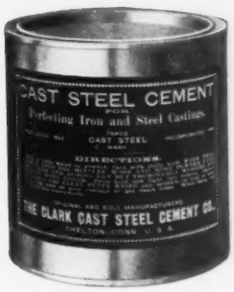

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THE FOUNDRY

Vol. 33, No. 3 CLEVELAND, OHIO, NOVEMBER, 1908 Whole No. 195

A DIFFICULT MOLDING MACHINE JOB

Making an automobile crank case mold on a pair of hydraulic molding machines---The patterns have numerous loose parts

THE manufacture of castings for automobiles has developed a distinct branch of the foundry industry and its growth has been concurrent with the rapid increase in the production of motor cars. Numerous gray iron plants have been built and equipped for casting engine cylinders exclusively, and malleable founders report that the tonnage from automobile makers is steadily growing. Brass founders likewise, are making a specialty of brass sections to meet the exacting requirements of this trade, while the aluminum casting industry traces its rapid expansion to this source, and aluminum, owing to its low specific gravity, is used extensively for motor car bodies, running boards, etc., and almost exclusively for crank and gear cases. Practically all of the castings entering into automobile construction are intricate in design, requiring a high tensile strength, and the metal thicknesses throughout all of the parts have been reduced to a minimum. The amount of core work involved in the molding of not only cylinders, but engine

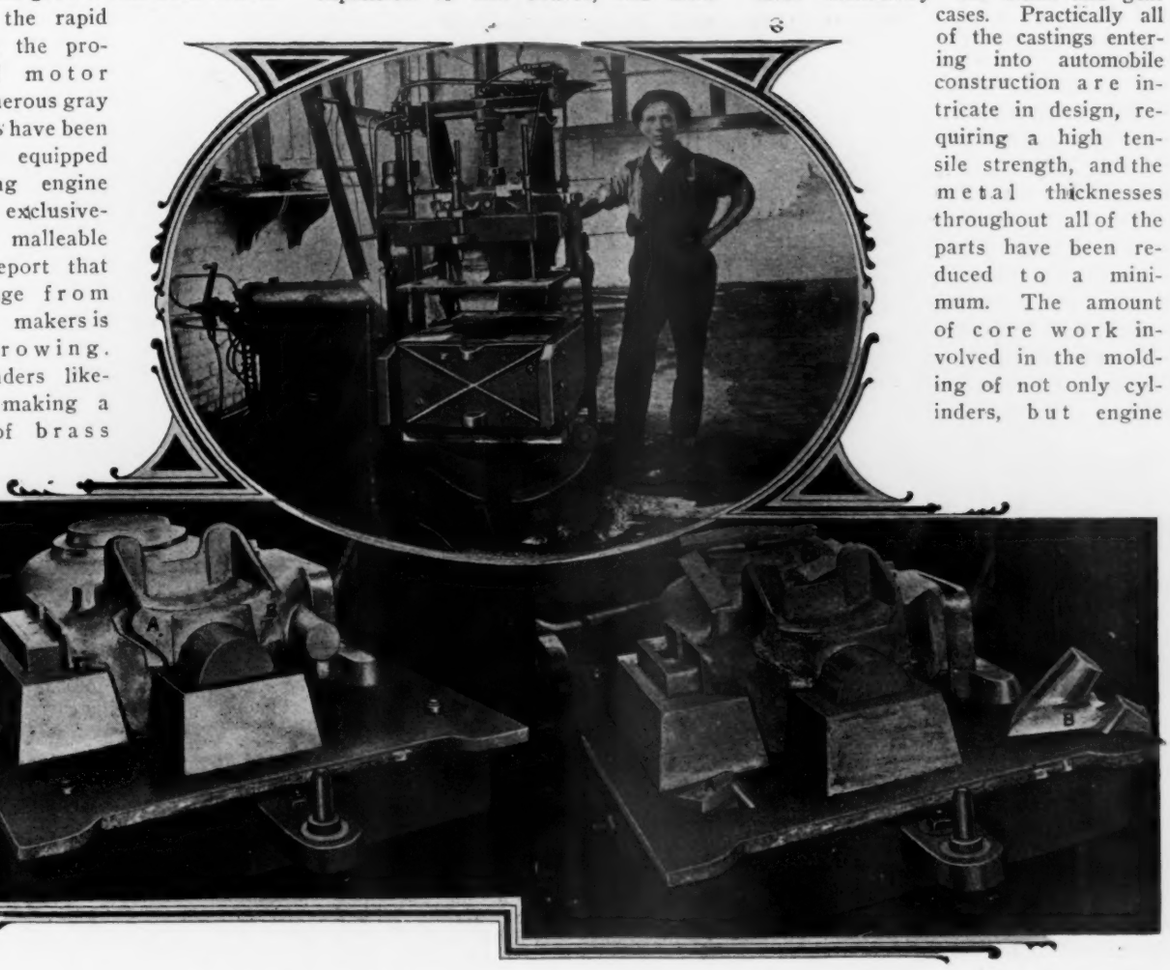

FIG. 1—SWINGING HYDRAULIC MOLDING MACHINE ROLLED OVER, SHOWING THE PATTERN WITHDRAWN FROM THE DRAG HALF OF THE MOLD

FIG. 2—THE WHITE METAL DRAG PATTERN, SHOWING LOOSE PARTS A AND B

FIG. 3—LOOSE PARTS AND STOOL PLATES REMOVED FROM THE DRAG PATTERN

and crank cases as well, is tremendous and the ingenuity of the patternmaker, core maker and molder is taxed to the limit in the production of some of these sections which bear evidence of having been designed without regard to the difficulties that will subsequently be encountered in the foundry.

The Allyne Brass Foundry Co., operating plants at Cleveland, Detroit and Buffalo, makes a specialty of brass and aluminum castings for the automobile trade, and to reduce the cost of molding wherever possible, patterns are mounted on molding machines when the order is for a sufficient number of sections to warrant this expenditure. Two hydraulic molding machines built by Ph. Bonvillain and E. Ronceray, Paris, France, and sold exclusively in the United States by the E. H. Mumford Co., Philadelphia, have recently been installed in the Cleveland foundry of the Allyne concern. For making the drags a swinging universal hydraulic machine is used designated as type R-3, the copes not being rolled over are made on an A-3 hydraulic molding machine.

Crank Case.

A crank case pattern for the motor of a White steamer was the first section mounted on these machines. Owing to its intricate design and the number of loose pieces in the pattern, no effort was made heretofore to make this casting on a molding machine. When made on the floor, the pattern was divided into four parts, requiring a four-part flask. The crank case is shown in Fig. 10, and the four parts of the wood pattern are shown in Fig. 12. The drag is shown in the upper left hand corner of this illustration, and the cope at the right. The loose pieces which form the lugs to which the engine cylinders are bolted are shown at K. The parts of the pattern from which the center sections of the mold are made are shown underneath the cope and drag respectively. Molding by hand, two castings were considered a good day's work by a molder and helper, but these machines have reduced the time for making each mold to 15 minutes.

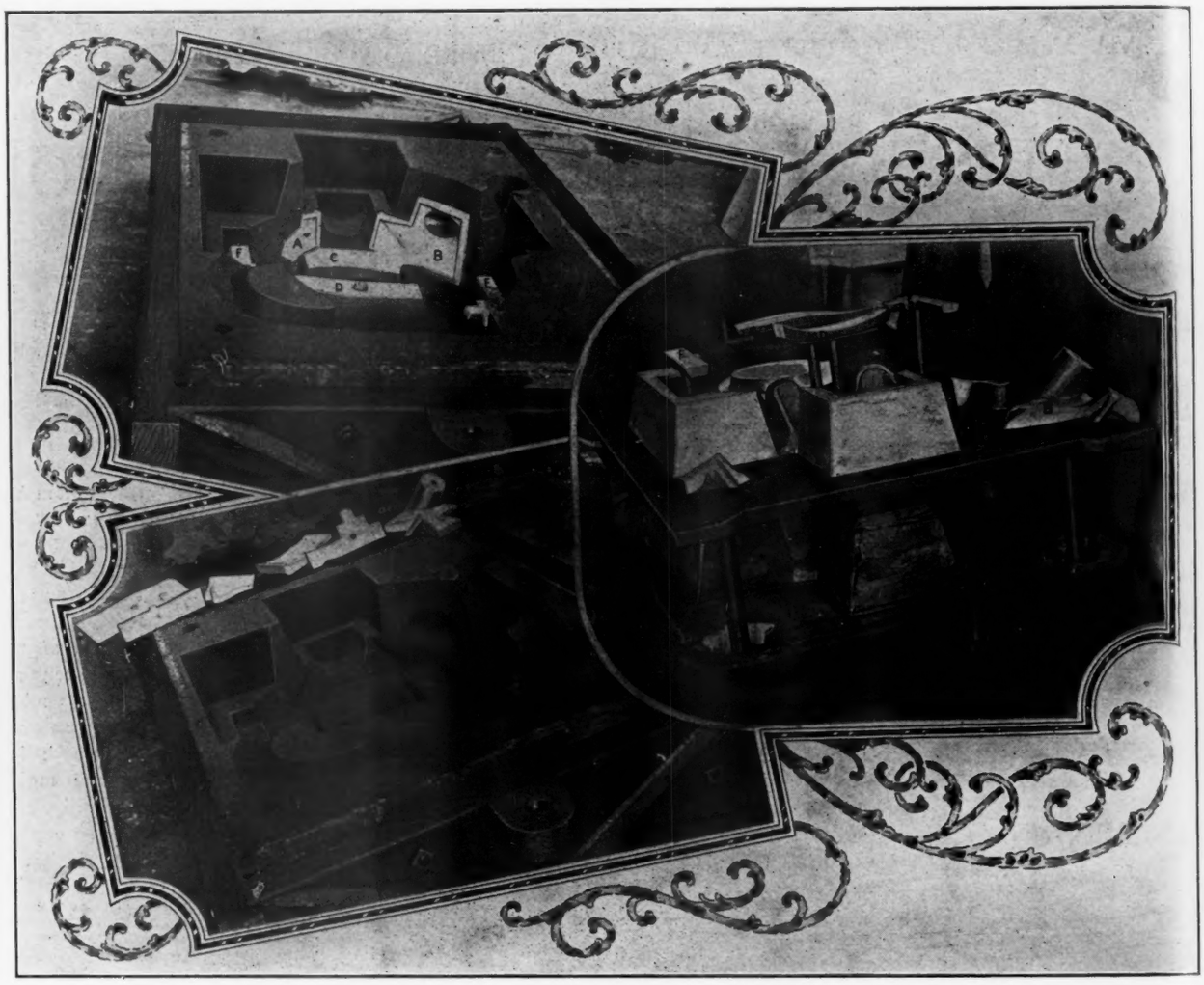

FIG. 4—DRAG MOLD SHOWING THE LOOSE PARTS OF THE PATTERN AND THE STOOL PLATES IN THE SAND

FIG. 5—LOOSE PARTS OF THE PATTERN WITHDRAWN FROM THE SAND AND STOOL PLATES REMOVED

FIG. 6—STRIPPING PLATE SHOWN ELEVATED, AND THE STOOL PLATES IN THE POSITION THEY ASSUME IN THE MOLD

Mounting the Pattern.

In mounting this pattern on these hydraulic machines it became necessary to divide it into two instead of four parts, and to draw the large boss B, Fig. 2, and H, Fig. 8, out of the sand by hand, as well as the lugs A, Fig. 2, and G, Fig. 8, and two other lugs in the cope not shown. These

constitute the loose parts of the pattern and slide in grooves, remaining in the sand when the pattern is withdrawn and are subsequently removed from the mold by hand. To support the sand in a number of deep pockets while the pattern is being withdrawn, and at several points where sharp angles are encountered with practically no draft, stool plates are used in both the cope and drag.

tern is shown in ramming position before the flask has been placed on the machine. The loose pieces A and B, as well as those in the cope, are cast of aluminum and fit into grooves in the white metal pattern. All of the loose pieces were first cast and were fitted in the mold from which the white metal pattern was made. This was done to avoid the necessity of subsequently machining the grooves. The drag after

boss, but a lug as well, which in design is similar to the lug shown at A. In Fig. 5 the loose pieces A and B, as well as the stool plates have been withdrawn from the mold and are shown at the end of the flask. The stripping plate, as well as the method of supporting the stool plates while the pattern is being withdrawn is shown in Fig. 6. The plates C, D, E and F are loosely mounted on rods, and by the

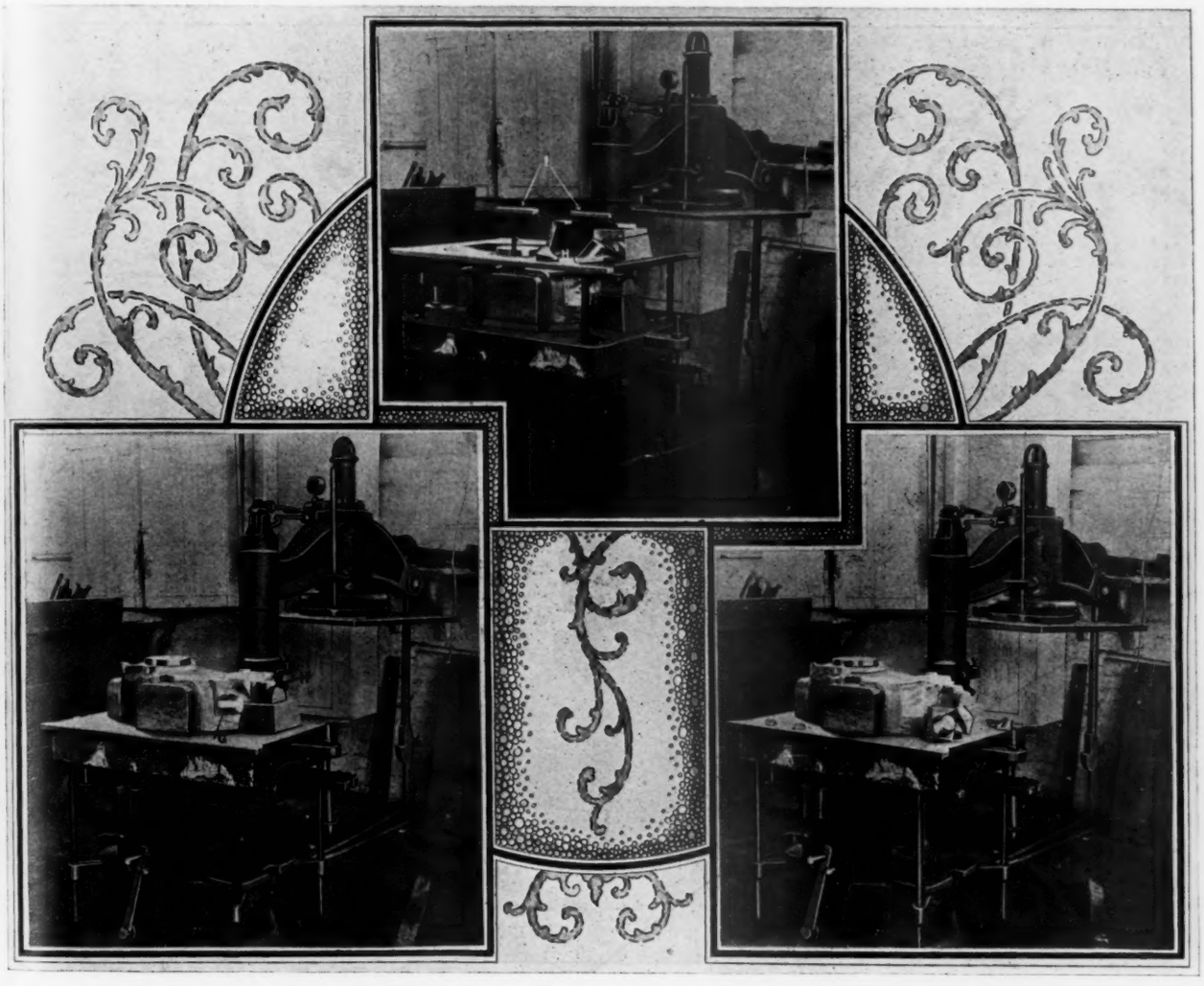

FIG. 7—COPE MACHINE SHOWING THE STRIPPING PLATE ELEVATED AND STOOL PLATES IN THE POSITION THEY ASSUME IN THE MOLD

FIG. 8—THE COPE PATTERN SHOWING THE LOOSE PARTS G AND H

FIG. 9—THE COPE PATTERN WITH THE LOOSE PARTS REMOVED

Making the Drag.

The swinging universal hydraulic machine on which the drag is mounted, rolled over after ramming, is shown in Fig. 1. The pattern has been withdrawn from the mold through the stripping plate which can clearly be seen. The stool plates and loose parts of the pattern are shown in Fig. 3, having been withdrawn from the recesses in which they slide, and have been placed on the pattern and pattern plate. In Fig. 2 the pat-

ramming with the stool plates still remaining in the sand, as well as the loose parts of the pattern, are shown in Fig. 4.

The loose sections A and B shown in Figs. 2 and 3 are shown in the sand in Fig. 4, and the stool plates C, D, E and F support heavy pockets of sand and protect sharp angles while the pattern is being withdrawn through the stripping plate. The loose part of the pattern B, not only consists of a heavy

upward movement of the stripping plate the loose pieces A and B are removed from the pattern and are permitted to remain in the sand to be subsequently withdrawn by hand.

The Cope.

The cope is made on a hydraulic molding machine, which is not of the swinging type owing to the fact that the mold is not rolled over. Four loose pieces are necessary for the produc-

tion of this mold on a molding machine. In Fig. 8 the lug is shown at H and a lug and a heavy boss at G, while the stool plates are shown at I, Fig. 7. Two other loose pieces likewise constitute a part of this pattern and form the other two lugs, to which the engine cylinders are fastened. After the mold has been rammed the pattern is stripped, but the stool plates I remain stationary to support the pockets of sand while the pattern is being withdrawn. Before the mold, however, can be lifted from the machine these stool plates are lowered and do not remain in the mold as they are fastened to the rods. In Fig. 9 is shown the cope pattern with the loose pieces G and H removed. In Figs. 7, 8 and 9 the presser head is shown swung aside after the ramming operation has been completed, to permit of the removal of the flask by an overhead pneumatic hoist which serves both machines.

Chills.

Notwithstanding the fact that there is considerable variation in the metal thicknesses of this casting, only two chills are used, which are located in the cores shown in Fig. 10. Eight cores are required, the main core being made in two parts. No bars are used in either the cope or drag flasks, although the body of sand is considerable, inasmuch as there is a 9-inch draw in the drag and 7¾ inch in the cope.

The flasks are 22 x 30 inches, the drag being 12 inches deep and the cope 10 inches deep. The mold is provided with a straight and forked gate, and the riser is placed at one end where the metal thickness is considerable and where no chills are used. The casting varies in thickness from 3/16 to ¼ inch and finished weighs 49 pounds.

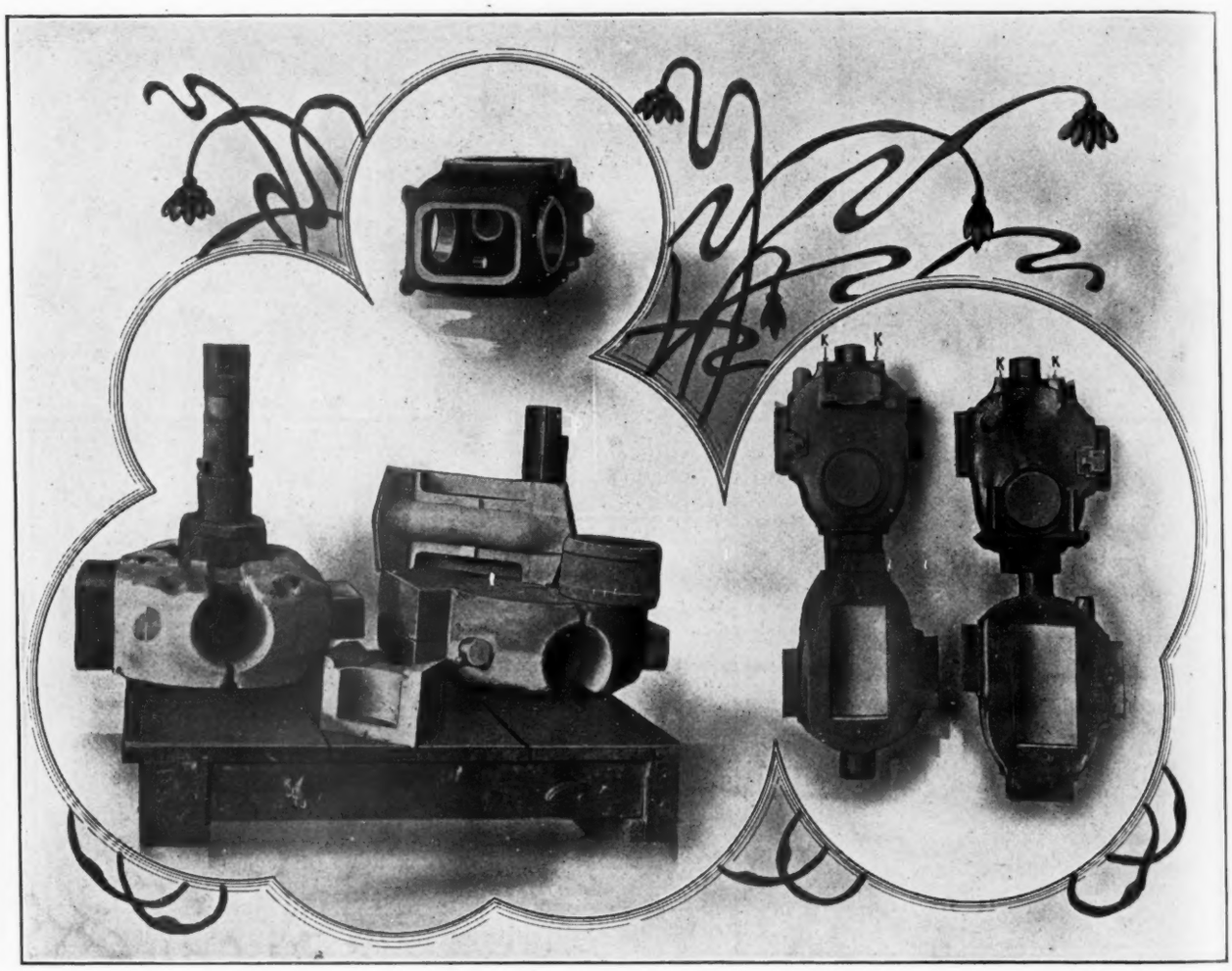

FIG. 10—THE FINISHED ALUMINUM CRANK CASE CASTING

FIG. 11—THE CORES

FIG. 12—THE FOUR-PART PATTERN USED FOR MOLDING THE CRANK CASE CASTING BY HAND

FOUNDRY FOREMEN'S ASSOCIATION AT PORTLAND, ORE.

At the fall meeting of the Oregon branch of the United Metal Trades Association of the Pacific coast, an organization embracing the metal manufacturers of the far west, which is to be held in Portland, Ore., the first week in November, steps will be taken to organize a Foundry Foremen's Association of Oregon. This Portland meeting is the first of a number that are to be held at various Pacific coast cities, at which points similar foremen's associations will be organized, it being planned to finally create a society which will occupy on the west coast a position similar to that now held by the Associated Foundry Foremen in the east. A dinner will be given at the Portland meeting to which all the foundry and machine shop foremen of Oregon have been invited to attend and meet with their employers. At that time letters from the east will be read explaining the work of the Associated Foundry Foremen and features of the Pacific coast situation will be discussed by prominent metal manufacturers.

COMPOSITION OF AUTOMOBILE CYLINDERS

The use of various grades of iron for making these difficult sections --- Physical tests

BY HARRY B. DE PONT

THE automobile cylinder or any other cylinder which has exploded in its combustion chamber a mixture of air and gas for the generation of power, should be made of carefully selected iron, and the castings should not be so hard to prevent easy machining. The assembling room relies upon the testing racks and in turn the latter depends upon the machine shop for material. If for some reason the cylinder cannot be machined with the usual speed, it is evident that the loss of time will necessarily hold back all subsequent operations on the casting after the machine shop has finished with its part of the work.

A cylinder casting calls for a grade of iron embodying chemical and physical properties which should enable it to show up satisfactorily from the time it leaves the foundry throughout the rest of its life, be it under the hood of an auto, or quietly situated in the basement of a laundry. Go into a shop where cylinders are being bored and listen to the machines. If the cylinders are very hard the machines will invariably labor, and the noise emanating from the tools may be heard for a radius of several hundred feet. The author has had occasion to follow the course of many heats of cylinders, his observations being made at intervals during the day.

Experience With Hard Iron.

Hard iron was ordered some time before the tests were made, and the number of cylinders turned out by the boring machines, both cuts, averaged about 11 per day, whereas 22 were turned on previous heats of softer castings. The tools used on the hard iron lasted about two days against five days when softer iron was used. It was suggested that the foundry be put back on soft iron for the cylinders.

The next batch of cylinders worked fairly well. The boring machines were able to get up to 21 per day, the tools lasting from four to five days. Suitable test pieces of the lot of soft castings were taken and analyses made. The cylinders continued to come soft and exhibited good physical properties from a high pressure hydraulic test. Some expressed fears as to the possibility of leakage owing to the coarse grain, but no leaks developed. The sulphur content was reduced from 0.132 per cent to 0.085 and 0.095 per cent. The silicon remained about the same.

Transverse tests were made from bars cast from cylinder heats whenever it was thought advisable to get a line on the physical properties. The analyses of the hard cylinders are given in Table I.

Table I.

	Silicon, per cent.	Sulphur, per cent.	Phosphorus, average per cent.	Manganese, average per cent.
No. 1...	1.82	0.132	0.480	0.544
No. 2...	1.82	0.125		
No. 3...	1.77	0.118		
No. 4...	1.68	0.116		
No. 5...	1.71	0.130		
No. 6...	1.84	0.136		
No. 7...	1.80	0.116		
No. 8...	1.90	0.128		

All of these samples would probably have had a transverse strength of approximately 1,500 pounds had they been tested. The sulphur content was too high for the silicon, the shrinkage was too high and the iron was too brittle to be easily machined. If the sulphur must be as shown, then it would be wise to increase the silicon in order to eliminate the excessive shrinkage and produce a tough strong iron suitable for light parts, such as are found in the walls of cylinders. An increase in manganese would help to offset the sulphur, but it would be better either to decrease the sulphur or increase the silicon about 3.00 per cent.

Analyses of the soft cylinders are given in Table II.

Table II.

	Combined carbon, per cent.	Graphitic carbon, per cent.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
No. 1...	0.90	2.40	1.72	0.090	0.463	0.50
No. 2...	1.34	1.90	2.10	0.080	0.644	0.58
No. 3...	0.96	2.50	2.00	0.072	0.548	0.58
No. 4...	1.35	1.80	1.96	0.078	0.452	0.60
No. 5...	1.09	1.97	1.82	0.090	0.493	0.60
No. 6...	0.27	3.13	2.00	0.084	0.517	0.55
No. 7...	0.79	2.62	1.73	0.100	0.537	0.44
No. 8...	0.47	2.34	1.86	0.075	0.380	0.46
No. 9...	0.37	2.99	1.85	0.084	0.420	0.52

The first five, from their combined carbon would appear hard. They were hard it is true, but not too hard to be machined, and represent a good grade of cylinder iron for automobile work. In tests Nos. 2, 4 and 5, it is the author's belief that a chilled surface was cut into, thereby giving the high combined carbon. It should be nearer 0.95 per cent, or possibly lower. The manganese is about right but could, however, be a little higher. The last four irons, with the exception of No. 7, are too soft, and, although their sulphur content is about right the manganese should be at least 0.15 per cent higher in order to toughen the mixture and give a suitable transverse test.

Physical Tests.

Unfortunately the chemical and phycal data of seven of the transverse bars was lost and tests of only five of the 12 bars are given in Table III.

Table III.

	Combined carbon, per cent.	Graphitic carbon, per cent.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.	Transverse strength, pounds.	Modulus of Elasticity.
No. 1.....	2.60	0.90	1.73	0.105	0.560	0.47	1,400	20,175,000
No. 2.....	2.25	1.01	1.60	0.116	0.531	0.49	1,600	20,280,000
No. 3.....	2.44	0.90	1.72	0.099	0.509	0.50	1,325	17,500,000 (approximately)
No. 4.....	3.09	0.63	1.82	0.086	0.483	0.48	1,250	14,900,000
No. 5.....	2.85	0.69	1.82	0.085	0.488	0.48	875	12,500,000

The first two, having the highest transverse strength and modulus of elasticity, have the highest sulphur content. The sulphur in No. 1 is not too high and the piece will machine fairly well, while the sulphur in No. 2 is a trifle high for the silicon and carries a high combined carbon. This piece will work hard and have a high shrinkage, but is, however, a strong

iron. The toughness is due to the sulphur which in turn is partly responsible for the high combined carbon. The other bars run low in sulphur and higher in silicon with carbons in proportion. Their physical properties are lower, due to a decrease in sulphur. If we wish to increase the transverse strength, instead of increasing the sulphur, we should use manganese and get the desired iron without resorting to high sulphur which causes hard iron and slow machining.

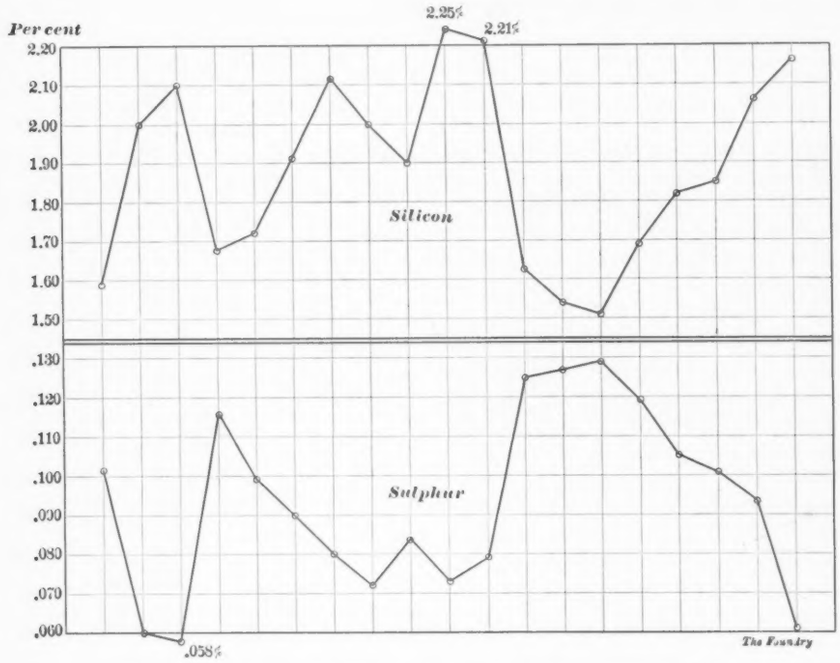

FIG. 1—CURVES OF SILICON AND SULPHUR IN CYLINDER IRON

Effect of Sulphur.

If we increase the silicon to 2.25 per cent and the sulphur to 0.115 per cent, the combined carbon will probably be in the neighborhood of 0.97 or 1.00 per cent, and from this combination we might expect a transverse strength of approximately 1,350 pounds per square inch. Sulphur gives strength and increases shrinkage, and throws carbon into the combined form. Within its allowable limit it is useful, but greater than this amount it works towards white iron and causes brittleness. If the sulphur increases we can logically expect the silicon to drop. This is graphically shown in Fig. 1. The curves were plotted from selected analyses for the purpose of showing the existing relations between silicon and sulphur. The higher the temperatures used for melting the greater the antipathy of silicon for sulphur, and the lower the melting temperature the nearer will the sulphur approach the silicon. This phase is peculiarly illustrated in the original process of reduction, that is in the blast furnace.

The silicon in the iron thus far discussed does not run over 2.40 per cent, this fairly low content being called for with correspondingly low sulphurs, the results obtained therefrom being satisfactory in every detail.

Fluid Iron.

For the general line of cylinders the necessary fluidity of the iron is obtained with a phosphorus content ranging between 0.35 and 0.50 per cent. In fact, most of the cylinders taken into consideration average about 0.495 per cent. It is not at all necessary to run the phosphorus up to 0.70 or 0.80 per cent to get the proper fluidity, for an iron with such a high phosphorus content would surely be weaker and hardly suitable for cylinder work. Keep the phosphorus as low as possible, use only enough to get a fast running iron, or an iron fast enough to run the mold. Phosphorus has been used to soften iron in place of increasing silicon or reducing sulphur, but whether the effect physically is as good as manipulating the silicon and sulphur remains to be seen. To equalize the hardening effect of high sulphur, the phosphorus would have to be increased to a point where the physical effect would result in weakening instead of strengthening the casting.

Analyses of High Silicon Mixtures.

Cylinders from which the drillings were taken are used by a reputable motor company and have the ear marks of fairly good iron. These cylinders were recently cast and can be classed with the very latest product of the automobile cylinder foundry. The analyses are shown in Table IV.

Table IV.

	Silicon, per cent.	Sulphur, per cent.	Phosphorus, average per cent.	Manganese, average per cent.
No. 1...	3.04	0.063	0.560	0.65
No. 2...	4.13	0.099		
No. 3...	2.88	0.058		
No. 4...	2.75	0.054		
No. 5...	2.75	0.053		
No. 6...	4.25	0.107		
No. 7...	3.11	0.070		

These cylinders machined easily. The chemical characteristics differed from those already discussed, in the silicon and sulphur content. These have a high silicon and fairly low percentage of sulphur, and in proportion to the silicon an average phosphorus of 0.560 per cent and manganese, 0.65 per cent. The highest sulphurs are found in Nos. 2, 6 and 7, being 0.099, 0.107 and 0.070 per cent respectively, with the silicons in order, 4.13, 4.25 and 3.11 per cent. Evidently, owing to the high sulphur, silicon was added in the shape of a softener. These irons are naturally softer than those referred to in the previous tables and all of the analyses indicate the allowable contents of silicon and sulphur in different grades of cylinders and show the diversity of opinion prevailing among foundrymen engaged in cylinder work.

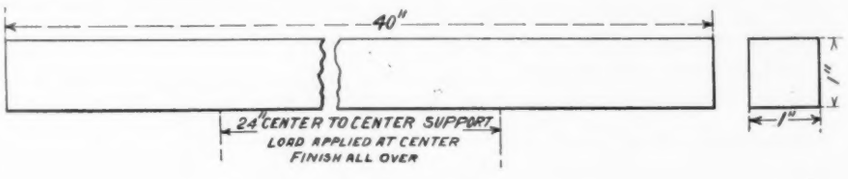

FIG. 2—TEST BAR

It is safe to assert that the manganese could be increased to an average of 0.80 per cent. This would make the castings tougher and would increase the transverse strength. The phosphorus is good and averages high enough for fluid iron.

Considering all of the cylinders tested, they are a pretty fair lot, and

THE FOUNDRY DATA SHEET, NOVEMBER, 1908.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

PATTERN SIZE AND WEIGHT O F CAST IRON PIPE, ¾ TO 2 9/32 INCHES THICK.

Thickness. inches.		¾	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16
40-inch Pipe	Pattern size, inches	42	42 1/16	42 1/8	42 3/16	42 1/4	42 5/16	42 3/8	42 7/16	42 1/2	42 5/8	42 5/8	42 11/16	42 3/4	42 13/16	42 7/8	43
	Weight, pounds....	3910	4075	4240	4405	4571	4737	4903	5070	5237	5404	5572	5740	5908	6077	6246	6415
42-inch Pipe	Pattern size, inches	....	....	44 1/8	44 3/16	44 1/4	44 5/16	44 3/8	44 7/16	44 1/2	44 5/8	44 5/8	44 11/16	44 3/4	44 13/16	44 7/8	45
	Weight, pounds....	....	....	4440	4615	4790	4965	5140	5316	5492	5668	5844	6021	6198	6375	6552	6730
48-inch Pipe	Pattern size, inches	....	....	....	....	....	....	50 7/16	50 1/2	50 5/8	50 5/8	50 11/16	50 3/4	50 13/16	50 7/8	50 15/16	51
	Weight, pounds....	....	....	....	....	....	....	5969	6068	6267	6467	6667	6867	7067	7268	7469	7670
60-inch Pipe	Pattern size, inches	....	....	....	....	....	....	....	....	....	....	62 7/8	62 15/16	63	63 1/16	63 1/8	63 3/16
	Weight, pounds....	....	....	....	....	....	....	....	....	....	....	8282	8532	8782	9032	9282	9532

Thickness, inches.		1 3/16	1 13/16	1 7/8	1 15/16	1 1/2	1 17/16	1 7/8	1 15/16	1 1/2	1 13/16	1 7/8	1 15/16	1 3/4	1 13/16	1 7/8
40-inch Pipe	Pattern size, inches	43 1/4	43 5/16	43 3/8	43 7/16	43 1/2	43 5/8	43 5/8	43 11/16	43 3/4	43 13/16	43 7/8	43 15/16	44	44 1/16	44 1/8
	Weight, pounds....	7267	7438	7610	7782	7954	8127	8300	8473	8647	8821	8995	9170	9345	9520	9688
42-inch Pipe	Pattern size, inches	45 1/4	45 5/16	45 3/8	45 7/16	45 1/2	45 5/8	45 5/8	45 11/16	45 3/4	45 13/16	45 7/8	45 15/16	46	46 1/16	46 1/8
	Weight, pounds....	7622	7801	7980	8160	8340	8520	8700	8881	9062	9243	9424	9606	9788	9970	10152
48-inch Pipe	Pattern size, inches	51 1/16	51 3/16	51 7/16	51 1/2	51 5/8	51 5/8	51 11/16	51 3/4	51 13/16	51 7/8	51 15/16	52	52 1/16	52 1/8	52 3/16
	Weight, pounds....	8679	8882	9083	9288	9491	9695	9899	10103	10307	10512	10717	10922	11127	11333	11539
60-inch Pipe	Pattern size. inches	63 1/2	63 5/8	63 3/4	63 13/16	63 3/4	63 13/16	63 7/8	63 15/16	64	64 1/16	64 1/8	64 3/16	64 1/4	64 5/16	64 3/8
	Weight, pounds....	10785	11086	11337	11588	11839	12091	12343	12545	12847	13099	13357	13603	13856	14109	14362

Thickness, inches.		1 13/16	1 7/8	1 13/16	1 15/16	1 13/16	2	2 1/32	2 1/16	2 3/32	2 1/8	2 5/32	2 3/16	2 7/32	2 1/4	2 9/32
40-inch Pipe	Pattern size, inches	44 3/8	44 1/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Weight, pounds....	9862	10048	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
42-inch Pipe	Pattern size, inches	46 3/8	46 1/4	46 3/8	46 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Weight, pounds....	10335	10518	10700	10885	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
48-inch Pipe	Pattern size, inches	52 1/4	52 5/16	52 3/8	52 7/16	52 1/2	52 5/8	52 5/8	52 11/16	52 3/4	52 13/16	.....	.....	.....	.....	.....
	Weight, pounds....	11745	11951	12158	12365	12572	12779	12987	13195	13443	13611	.....	.....	.....	.....	.....
60-inch Pipe	Pattern size, inches	64 7/16	64 1/2	64 5/8	64 3/4	64 13/16	64 1/4	64 13/16	64 7/8	64 13/16	65	65 1/16	65 1/8	65 5/16	65 1/4	65 7/16
	Weight, pounds....	14615	14868	15121	15374	15628	15882	16136	16390	16644	16898	17152	17407	17662	17917	18172

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Lumber Measure.

LENGTH IN FEET.

SIZE.	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1 x 8	8	9⅓	10⅔	12	13⅓	14⅔	16	17⅓	18⅔	20	21⅓	22⅔	24	25⅓	26⅔
1 x 10	10	11⅔	13⅓	15	16⅔	18⅓	20	21⅔	23⅓	25	26⅔	28⅓	30	31⅔	33⅓
1 x 12	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1 x 14	14	16⅓	18⅔	21	23⅓	25⅔	28	30⅓	32⅔	35	37⅓	39⅔	42	44⅓	46⅔
1 x 16	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔	45⅓	48	50⅔	53⅓
2 x 3	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2 x 4	8	9⅓	10⅔	12	13⅓	14⅔	16	17⅓	18⅔	20	21⅓	22⅔	24	25⅓	26⅔
2 x 6	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
2 x 8	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔	45⅓	48	50⅔	53⅓
2 x 10	20	23⅓	26⅔	30	33⅓	36⅔	40	43⅓	46⅔	50	53⅓	56⅔	60	63⅓	66⅔
2 x 12	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
2 x 14	28	32⅔	37⅓	42	46⅔	51⅓	56	60⅔	65⅓	70	72⅔	79⅓	84	88⅔	93⅓
2 x 16	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓	90⅔	96	101⅓	106⅔
3 x 4	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3 x 6	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
3 x 8	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3 x 10	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
3 x 12	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
3 x 14	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
3 x 16	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
4 x 4	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔	45⅓	48	50⅔	53⅓
4 x 6	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
4 x 8	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓	90⅔	96	101⅓	106⅔
4 x 10	40	46⅔	53⅓	60	66⅔	73⅓	80	86⅔	93⅓	100	106⅔	113⅓	120	126⅔	133⅓
4 x 12	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
4 x 14	56	65⅓	74⅔	84	93⅓	102⅔	112	121⅓	130⅔	140	149⅓	158⅔	168	177⅓	186⅔
4 x 16	64	74⅔	85⅓	96	106⅔	117⅓	128	138⅔	149⅓	160	170⅔	181⅓	192	202⅔	213⅓
6 x 6	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
6 x 8	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
6 x 10	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
6 x 12	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
6 x 14	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280
6 x 16	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
8 x 8	64	74⅔	85⅓	96	106⅔	117⅓	128	138⅔	149⅓	160	170⅔	181⅓	192	202⅔	213⅓
8 x 10	80	93⅓	106⅔	120	133⅓	146⅔	160	173⅓	186⅔	200	213⅓	226⅔	240	253⅓	266⅔
8 x 12	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
8 x 14	112	130⅔	149⅓	168	186⅔	205⅓	224	242⅔	261⅓	280	298⅔	317⅓	336	354⅔	373⅓
8 x 16	128	149⅓	170⅔	192	213⅓	234⅔	256	277⅓	298⅔	320	341⅓	362⅔	384	405⅓	426⅔
10 x 10	100	116⅔	133⅓	150	166⅔	183⅓	200	216⅔	233⅓	250	266⅔	283⅓	300	316⅔	333⅓
10 x 12	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
10 x 14	140	163⅓	186⅔	210	233⅓	256⅔	280	303⅓	326⅔	350	373⅓	396⅔	410	443⅓	466⅔
10 x 16	160	186⅔	213⅓	240	266⅔	293⅓	320	346⅔	373⅓	400	426⅔	453⅓	480	506⅔	533⅓
12 x 12	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480
12 x 14	168	196	224	252	280	308	336	364	392	420	448	476	504	532	560
12 x 16	192	224	256	288	320	352	384	416	448	480	512	544	576	608	640
14 x 14	196	228⅔	261⅓	294	326⅔	359⅓	392	424⅔	457⅓	490	522⅔	555⅓	588	620⅔	653⅓
14 x 16	224	261⅓	298⅔	336	373⅓	410⅔	448	485⅓	522⅔	560	597⅓	634⅔	672	709⅓	746⅔
16 x 16	256	298⅔	341⅓	384	426⅔	469⅓	512	554⅔	597⅓	640	682⅔	725⅓	768	810⅔	853⅓

Note:—By simply multiplying or dividing the above amounts, the number of feet contained in other dimensions can be obtained.

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Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

are representative of the work of several well known foundries. The analyses contained in Table V should prove satisfactory for the average line of cylinders:

Table V.

	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
No. 1...	1.60	0.050	0.450	0.70
No. 2...	1.80	0.060	0.450	0.80
No. 3...	2.25	0.065	0.450	0.90
No. 4...	3.00	0.075 or 0.080	0.450	1.00

Piston Rings.

The mixture for piston rings should be carefully selected. The analyses shown in Table VI are fairly good for this particular work, No. 3 being the best, inasmuch as it is sufficiently hard without over-running the danger point.

Table VI.

	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
No. 1...	1.85	0.086	0.532	0.66
No. 2...	1.96	0.091	0.544	0.61
No. 3...	1.74	0.094	0.463	0.62
No. 4...	1.80	0.080	0.491	0.58

The manganese is high enough to counteract the bad effects of the sulphur, but could, however, be a trifle higher. It might seem wiser to some to use a silicon content of about 2.50 to 3.00 per cent. This could be done, but it would be more advisable to use a little higher sulphur and run up the manganese. An iron of high transverse strength is called for in the rings which must have a certain degree of hardness. It does not seem necessary to use a very high phosphorus in this case for a phosphorus content of 0.300 to 0.350 per cent would do.

In Table VII are given five piston ring analyses which gave excellent results:

Table VII.

	Silicon. per cent.	Sulphur. per cent.	Phosphorus. per cent.	Manganese. per cent.
No. 1...	2.66	0.096	0.557	0.58
No. 2...	2.41	0.093	0.541	0.55
No. 3...	1.75	0.086	0.561	0.71
No. 4...	1.70	0.085	0.582	0.76
No. 5...	1.94	0.080	0.495	0.74

These mixtures were satisfactory with the exception of Nos. 1 and 2. The manganese could have been increased to 0.68 per cent for No. 1 and to 0.65 per cent for No. 2. The silicon and sulphur are high enough to warrant a big increase in manganese. The last three are a trifle harder and show up better in strength than Nos. 1 and 2. With the silicon lower and sulphur in proportion, we find a manganese content higher than usual, offsetting any excessive hardness and giving toughness and transverse strength. The analyses show the iron to be suitable for the work for which the iron is intended.

Effect of Manganese.

Manganese is a good hardener and makes the iron tough. It is different from sulphur inasmuch as it can be used in excess without producing mottled iron or causing brittleness. There is known to furnacemen, especially those who have charge of the breaking and handling of the iron, a chill called the manganese chill. When a cast runs 0.75 per cent silicon, 0.019 per cent sulphur, 0.85 per cent manganese and 0.215 per cent phosphorus, we look for a hard breaking tough iron with a high transverse strength. In a low silicon, hard breaking iron we invariably look for a high manganese. One positive proof of this manganese effect is the fact that iron of practically the same silicon, sulphur and phosphorus, but low in manganese has been found to be very much inferior to the high manganese iron in breaking qualities. Now the question is, would it work in the remelt and how would the naturally high sulphur be affected? The analyses of several low sulphur charcoal irons indicate that a low percentage of sulphur is an absolute necessity.

RAPPING PLATES --- A DISCUSSION OF THE PROPER USE AND ABUSE OF PATTERNS

BY C. NEILL

ON FLOOR and bench work it is a question whether the period of usefulness of a pattern is shortened by careless and rough usage in the hands of the molder, or whether the fault lies in the improper placing of the rapping plate, and the utter disregard of its presence by the molder who drives a spike in the wood alongside of it because the tapped hole for the key is caked with sand as hard as flint or probably the plate is entirely absent. It is absurd to see a patternmaker spend time and skill in producing a pattern which is perfect so far as the workmanship and general outlines are concerned, which is then carried to the blacksmith shop for a plate which is put on the pattern as shown in Fig. 1. The hole in the center being tapped,

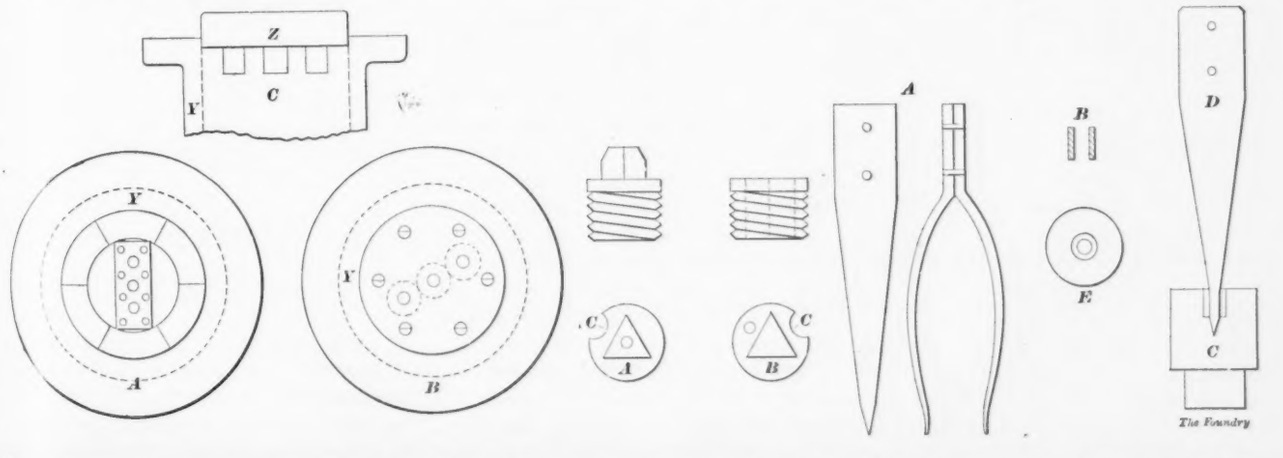


FIG. 1—PROPER AND IMPROPER RAPPING PLATES

FIG. 2—TRIANGULAR PIN AND SOCKET FOR SMALL PATTERNS

FIG. 3—TWEEZERS USED FOR DRAWING SMALL PATTERNS

the segments outside the plate formed the core print. These patterns were in constant use, so much so that if any repairs were needed they had to be made between 3 p. m. and 7 a. m. the following day. The segments at

FIG. 4—TOOL USED FOR SCREWING THE SOCKET IN PLACE

A were constantly being knocked, the screws in the plate jarred loose, or some other mishaps occurred. The molder, in some cases, used the projecting print to pound against with a copper hammer until the shape of the core print became such that the core would not fit into the mold and trouble ensued. As the casting at Y was only ⅜-inch thick, the slightest variation of the core made one side thick and another thin, producing castings which would not stand a water test with pressure.

An Improved Plate.

The rapping plate at B, Fig. 1, was then put on, the gray iron plate being ⅝-inch thick, with ¼-inch allowance on the outside diameter for finish. Three projections were put on the bottom, 1¼ inches in diameter and

FIG. 5—TOOL USED FOR INSERTING OR REMOVING BRASS DOWELS

1½ inches long, for rapping and lifting holes. The pattern was rechucked in the lathe and recessed for the plate Z as shown, and three holes were bored for the projections on the bottom of plate. The corner at the top of the plate Z was rounded off 1/16 inch and the plate was screwed on with six No. 20 wood screws, 3½ inches long. Most of the patterns of this class had these plates put on two or three years ago and as far as the plates are concerned are in fair condition today. To obtain such good results the foreman of the foundry was asked to co-operate by insisting that his men use the proper holes in the plates put there for that purpose.

The pattern carriers now, instead of holding a morning and afternoon conference, spend their spare moments each day in cleaning out the holes in the rapping plates before the patterns are put away and before they reach the molder. Three or four punches, twist drills and a few taps with a brace were added to their kit, and the firm began to realize this rapping contest was only beginning.

The core print Z will appear to many molders and patternmakers as

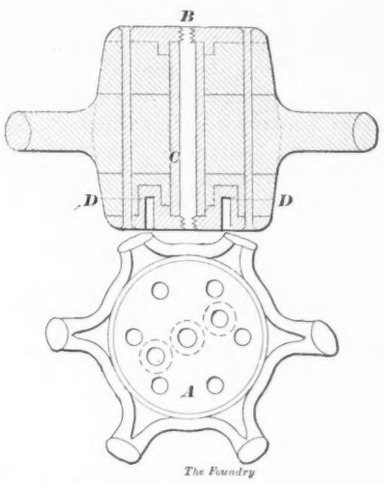


FIG. 6—PLATES APPLIED TO BOTH SIDES OF THE HUB FACE OF A WHEEL PATTERN

not good practice, the correct shape for core print of course being tapered; but these patterns, when the iron plates were put in were changed, the patterns being rammed up on a plate instead of a bottom board. One cope plate only was required for a number of patterns unless two patterns were in use at the same time, then two plates were necessary. Thus the entire cope, core, gates and runners, and in some cases as many as 20 small bolt hole cores were all made in one cope. This was necessary to get the best metal at the bottom and not at the flange end of the casting.

Fig. 2 shows a triangular pin and socket for the same pin, used for small patterns where it is not possible to put two pins of a reasonable size. Any molder who has handled much small work will agree in condemning the practice of using very small pins, as it is next to impossible to keep the sand out of the holes and just about as difficult to remove it. The pin and socket shown at Fig.

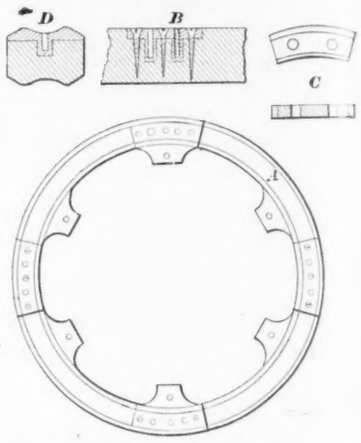


FIG. 7—GEAR RIM PATTERN WITH RAPPING PLATES IN POSITION

2 screw in a small hole 3-16-inch in diameter, drilled in the center of the triangular pin at the top about ¼-inch deep, and a small square punch driven in the hole makes it a square instead of round. The punch is then put in a brace or in a tool handle and screwed in, and the socket is screwed in with the tool shown in Fig. 4 which is made by grinding up an old 9-inch taper saw file and fitting a handle on it. Two of the small pieces of pipe shown at B, Fig. 3, are driven in a hole previously bored for them at C, Fig. 2. This prevents the pin from turning. The hole in the center of the pipe shown at B, Fig. 3, is used for the rapping and lifting.

Use of Tweezers.

The tweezers shown at A, Fig. 3, are used instead of a key or spike. At E, Fig. 3, is shown a small pattern with the small pipe B in it, and

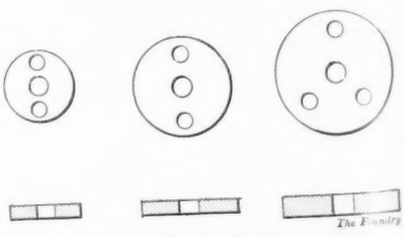


FIG. 8—SMALL ROUND RAPPING PLATES

C, Fig. 3, shows the pattern being drawn from the mold with the tweezers inserted in the hole in the pipe. In some cases a 1-16-inch hole bored in a hardwood pattern will suffice for the entrance of the points of the tweezers.

For small particular work the use of the tweezers will be found to be not only quicker but better than a 3/16 or ¼-inch threaded piece of iron with one end bent round to form a ring. They can also be used in rapping plates which have a small hole in them, using the tweezers in place of a key, or in picking out loose pieces in the bottom or side of a mold. These little tweezers, if made the correct shape, will be found to be indispensable.

Dowels.

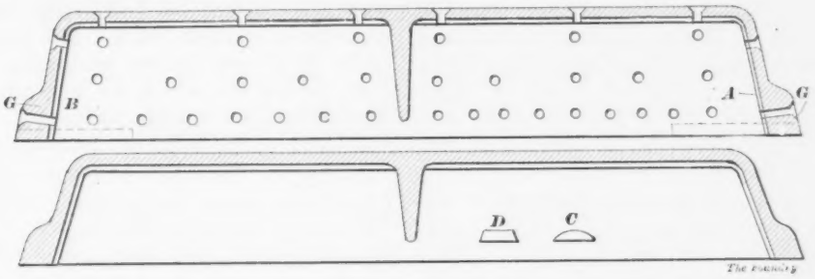
Fig. 4 shows a tool for screwing in or taking out brass dowels. Fig. 5 shows it in the dowel. A three-cornered tool does not mar the edges as much as a four-sided one does. A 3/16-inch hole drilled in the center of the pin is punched with a square punch, so the pin part can be either screwed in or out without marring the pin. The threaded brass dowels are more desirable than those with a small straight recess on the sides. Any one who has tried to remove the dowel with straight recesses and not threaded knows the impossibility of getting the dowel or socket out without destroying its further usefulness or the further use of the hole it occupied for a dowel. Dowels are apparently small matters in a pattern, but upon them depends a proper match or location of different parts. Poor dowels give poorer castings. Again, some patterns, no matter how carefully made, will warp in the center or where the joint comes where the dowels are and must be leveled or planed off true. In this case the socket and pin can be screwed out, a light cut taken on the jointer, or trued by a hand plane and the pins and sockets put back in the same holes in short order, which could not be done with the straight turned recess dowels.

Rapping Plates for Hub Patterns.

Fig 6 shows two plates, either cast brass or gray iron, as applied to both sides of a face of a hub on a wheel pattern. Any foundryman who has handled much wheel work will readily appreciate this hub construction.

The plate shown at B, Fig. 6, is cast brass, ½ inch thick with a projection at the center for the pipe C, which should fit well.

Two lugs are put on the cope side at D for rapping holes. These holes should not be drilled all the way through the hole in the center, but each side should be drilled in the center of each plate. They should then be fastened together with a bolt and the six holes 17/64 in diameter drilled for the ¼-inch rivets. The bolt is then taken out and rivet holes countersunk on the face side of each for riveting. The center holes are then tapped for a ½ or ⅝-inch thread and the hub is bored for the pipe in center all the way through. Two holes are bored for the projecting lug on the rapping side of the pattern. The plates are then put on the hub and riveted. The four remaining rivets are now bored from either side and riveted up and, if possible, the wheel rechucked and the plates are trued up on a slow speed with a file or a diamond point made from a smooth file, and finished with emery cloth. The pipe in the center allows a passage for any sand which may get in there and a small punch will drive it clear through, so at all times the tapped hole is clear for a key.



FIGS. 9 AND 10—CROSS SECTIONS AT THE END AND MIDDLE OF BED PLATE PATTERNS

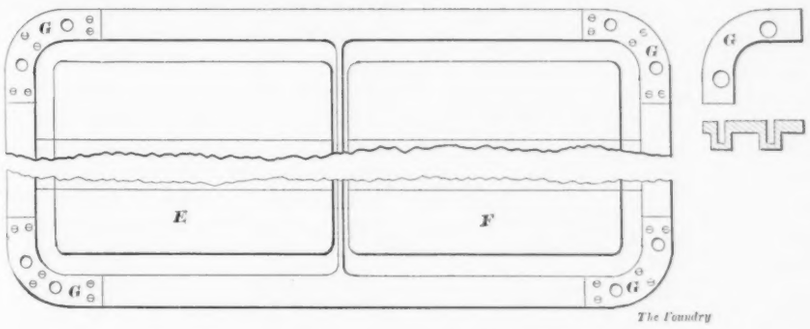


FIG. 11—VIEW OF BED PLATE PATTERN SHOWING THE FOUR RAPPING PLATES

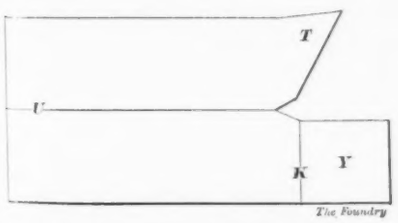
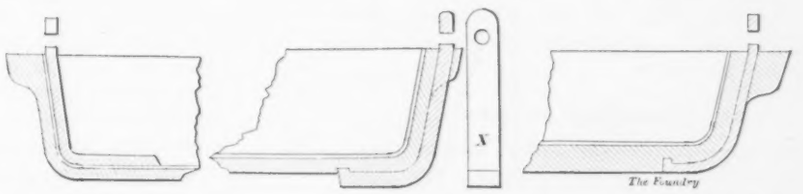


FIG. 12—SECTION OF PLATE FOR PATTERN LINING

Plates for Gear Rim Pattern.

Fig. 7 shows a rim pattern for a gear, either external or internal. These rims are bolted on projecting arms in the center. The one shown has a 4-inch rim, 4-inch face and is 30 inches in diameter. A top view of the rim with four rapping plates the full width of the rim screwed on is shown at A; B shows the rim and rapping plate in section with screws and two lugs, one for rapping and the other for lifting the pattern. The tap hole and rapping hole are not drilled all the way through the metal unless the lug extends through to the opposite face of the pattern; C shows the rapping plate patterns or templet; D is cross section of the rim. These rims as a rule are built up of four courses of five to twelve segments glued, without nails or screws. The two outside courses are hard wood and in turning the dowel side is finished last, the face being left 1/16 inch thicker than the size required. The rim on the face board is taken to the bench and four spaces from 3½ to 5½ inches long are cut about 7/16 inch deep, using a router to get the exact depth and making each one the same. Temporary pieces are screwed in each space, the whole put in lathe and finished to size. Three of the



FIGS. 13, 14 AND 15—APPLICATIONS OF LIFTING PLATES TO THE BED PLATE PATTERN

temporary pieces are removed and in one are bored two 1⅜-inch holes, shown at C, 1⅞ inches deep. This piece, C, from which the pattern for the rapping plate is made, is now placed in each of the three remaining recesses and the two 1⅜-inch holes bored as before. In the holes in C are now put two plugs 1⅜ inches in diameter and 1⅞ inches long, which are glued in. On each end of the pattern is now glued a piece of paper to provide for the shrinkage and four castings are made. If the rim is very wide the pattern can be rapped sufficiently to make up for such shrinkage, so that no finishing except slight filing or smoothing with emery cloth is required. Brass is preferred and will pay in the long run. The screw holes are drilled and countersunk and rapping and top holes drilled and put on with screws as long as the wood will permit. The time consumed in cutting and fitting the pattern will not take as long as fitting the flat wrought iron plate. These rapping plates will withstand the roughest usage a molder can give them. The lug holds the plate in position and the strain on the screw is only that necessary to hold it down to the wood.

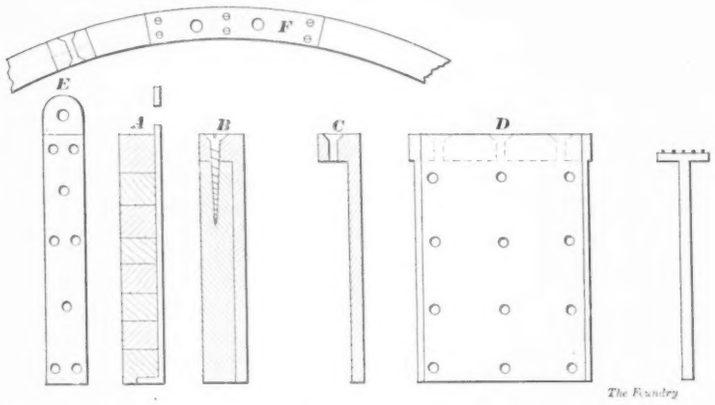
Fig. 8 shows three sizes, ½-inch, ¾-inch and 1-inch diameter, ⅛ inch and 3/16 inch thick, of little round rapping plates made from cold rolled polished steel. The center hole is a tap hole, the others screw holes, although where it is possible, copper rivets are better in all cases when they can be used.

Plates for Bed Plate Patterns.

Fig. 9 shows a bed plate pattern ⅜ inch thick at the top and sides except at G, which is about 1¼ inches thick. This view is cross section at the ends. Fig. 10 is a section at the middle, and Fig. 11 is the bottom view showing the four rapping plates at G, of which a section is also shown. The pattern is fitted and made the same as C, Fig. 7; E and F are linings for the inside of the bed 1/32 inch thick, made of soft steel or sheet iron. Galvanized iron can be used in some cases where there is not too much bending or hammering. These linings are riveted with copper rivets. The holes for the head of the rivet in the wood should be countersunk with a good-sized bit. The rest will draw up in riveting. A flat iron plate is the best thing to use in riveting a piece on the bottom of the iron plate. Care must be taken not to leave too much to rivet up or the lining will be drawn in at each rivet. Fig. 12 shows the development of the lining. The best plan is to cut a piece of thick wrapping paper to the correct size and shape. This can afterward be glued to a board and cut out on the band saw. The lining should be drilled and countersunk before bending to shape. A block of wood the depth of the bed inside and with both bevel and a round to fit the fillet at U, K and T in the corners, will make the bending of the corners an easy matter. This lining will hold the pattern square to its size and shape, and as the top of a bed is the first part to wear, the rivets can be punched out, a new top put on, and the pattern will not lose its proper size or shape while being repaired.

The lifting plate for the bed patterns shown at X, Fig. 13 shows a method of fastening it to the inside by which can be more easily stopped off in the mold. Fig. 14 shows it applied to the outside. Fig. 15 shows it applied to a pattern. These plates are wrought iron pieces having a hole at the top for ¾-inch or ⅞-inch bars, which can be run through the holes from one side to the other for lifting the patterns without much rapping.

Fig. 16 shows a rapping plate for a large rim or drum pattern made in brass. The rim is built up of segments as shown at A; B shows the rim and rapping plate in section; C shows the rapping plate in section, and D is an inside view of the rapping plate, showing the screw holes in top and rivet holes in the side. E shows the lifting plate, which is let in on the inside and used the same as those on the bed. Fig. 17 is a special rivet for patterns. It has a large flat head with small projections to keep it from slipping off the iron which is held against it while riveting.



FIGS. 16 AND 17—RAPPING PLATES FOR LARGE RIM OR DRUM PATTERNS AND SPECIAL RIVET USED IN THEIR CONSTRUCTION

ANNUAL MEETING OF THE LANCASHIRE BRANCH, BRITISH FOUNDRYMEN'S ASSOCIATION.

At the fourth annual meeting of the Lancashire branch of the British Foundrymen's Association held on Saturday, Oct. 3, at the Victoria hotel, Manchester, Percy Longmuir read a very interesting paper on "Alloys." In his opening remarks he showed that the fusion of various metals produced alloys which exhibited properties not possessed by the metals individually and this fusion likewise altered the melting point. He also cited instances of two metals being alloyed in their solid state by pressure without fusion taking place. After considering the ferrous alloys, Mr. Longmuir dealt with the various brasses and pointed out the effect of varying percentages of copper and zinc upon mechanical tests, as well as small additions of aluminum, lead and manganese. In the consideration of bronzes it was shown that manganese acts as a cleaning agent in the crucible and is practically all carried away in the slag. On the subject of phosphor bronzes it was shown that by increasing the percentage of phosphorus from 0.40 to 1 per cent, a very much harder alloy is obtained.

The advantages of a receiver for holding the metal tapped from the cupola were discussed at length. The general verdict was that while a receiver had some advantages in the way of securing clean iron and a uniform mixture, these were not sufficient to justify the extra cost of operation and maintenance, and the risk of accident which undoubtedly accompany the use of these reservoirs.

Officers for the ensuing year were elected as follows: President, R. W. Kenyon, Accrington; vice president, G. Buchanan, Wrexham; executive committee, Messrs, J. Kenyon, Markland, Mason, Penlington, W. H. Sherburn, Simkiss, Skelton and Wright; secretary, H. Sherburn, Warrington.

Following the meeting the first annual dinner was held, at which about 45 members and their friends were present.

THE SAND BLAST IN THE FOUNDRY---1

The first of a series of articles on the installation and use of the sand blast for cleaning castings

BY JAMES M. BETTON

IT IS proposed to consider the sand blast and its application to foundry service in the following, and to make as clear as possible a subject which has, up to within a year or two, been quite as much veiled in a sort of semi-mystery as the operator has usually been in his dust. The sand blast was admitted into the foundry slowly at first, but with each year its value is more and more appreciated, and today it is a part of every well equipped, modern and up-to-date foundry, lessening the cost of production, and giving a finish to the castings that is not found on those cleaned by hand in the old way.

Necessity For the Sand Blast.

While the necessity for the sand blast varies with the kind of facing used as well as with the quality of the molding sand, there are few iron castings made that are not benefited, both in appearance and wearing qualities, by being subjected to the abrasive action of sand under a moderate air pressure. The burnt sand and scale are removed and the actual surface of the metal is exposed, ready to receive the cutting tool. The clean lines of the casting are not defaced, and the work of cleaning is done with the greatest despatch.

An early objection to the adoption of the sand blast lay frequently, and this at times occurs today, in the expense necessary to complete the outfit. It was not the cost of the sand blast itself, for that, unless it included some special arrangement, or sand and dust handling devices, was generally reasonable, but its use implied the expense of an air compressor and an air receiver, and this in many instances caused the proposition to use this tool to be laid on the table.

Compressed Air in the Foundry.

As years passed, various pneumatic tools were invented, and the far sighted foundryman recognized and admitted the value of rammers, shakers and chipping tools, and when considering their adoption, figured also on obtaining a compressor which would give air enough for a sand blast as well. Some of the various forms of molding machines also call for the use of compressed air, and the growing use of pneumatic tools has done much to increase the use of the sand blast; and now the progressive foundryman will always make a suitable allowance for a supply of air to operate both the tools and the sand blast plant.

Today many foundries are equipped with sand blasts, and it is but a question of time when every plant of reasonable size and activity will use this machine in connection with other air tools. The sand blast thoroughly cleans the castings subjected to this treatment as the jet of air and sand penetrates into every angle and corner, cleaning them far more thoroughly than can be done by hand with scrapers, wire brushes, old files, and emery stones, without injury to angles, sharp edges, and fine lines, and with such rapidity that one man can easily clean as much work as six hand cleaners.

Earliest Application of Sand Blast.

The earliest sand blast and the application of a combined jet of air and sand for the purpose of cleaning castings, was made in the United States in 1870. Since then many forms of sand blasts have been patented and offered for sale. In the earlier and in many of the later forms of this machine, the sand is propelled by a jet of air striking it as it trickles down from an overhead sand tank, and the whole admixture and mingling of the air and sand take place in the delivery hose, which is necessarily of large diameter and cumbrous to handle. In one of the later forms, the mixture of the air and sand takes place in a specially designed mixing chamber into which the air is admitted progressively through three jets, each supplementing the other, the mixture of air and sand being most intimate and thorough, passing through the delivery hose, of moderate diameter, at a very high velocity, with corresponding force and cutting effect.

Selecting the Equipment.

The principal points to be observed in the selection of a sand blast are, capacity for sand, which should be generous for foundry work, as the larger the sand tank, the less often will it have to be refilled and the operator taken from his work; strength and design to enable it to withstand not only the ordinary working pressure for sand blasting, but the full air pressure of the system, to which it may be subjected, without danger of bursting; simplicity of operation, as it often has to be handled by ignorant and heavy handed labor; freedom from working parts subjected to the action of the sand; accessibility for repairs and the most thorough admixture of the air and sand.

Sand blasts having insufficient capacity, poorly constructed tanks of thin material which will give way under the heavy knocks which they will receive, and those in which the sand is controlled by ordinary commercial gate valves, and in which ordinary iron pipe fittings form a large part of the construction, are undesirable, for such valves and fittings will not stand the action of the sand for any length of time. Although the first cost of these fittings and valves may be comparatively small, when it comes to replacing them, unless union joints are introduced, it will be found generally, that the work will have to be gone over from beginning to end, and at a very considerable cost for time and delay.

Air Pressure.

Most sand blasts are operated under a moderate air pressure, not exceeding 30 pounds, but in some of the later types, an air pressure of 80 to 100 pounds is used, principally because that pressure is usually installed for the proper operation of pneumatic tools, and it does not seem desirable to use a reducing valve and cut down the pressure.

A high air pressure implies the use of a nozzle of small diameter, otherwise the consumption of air would be enormous and but few air plants could

meet the demand. The disadvantage of the small nozzle is that it limits very materially the sand that can be used, as only a moderately fine grade will pass through a ¼-inch nozzle, which is generally used with high pressures, without obstructing it, and it is often desirable to use large sand or fine gravel for cleaning. The cost of maintaining the pressure is naturally greater for a given quantity at a high pressure than for low, and although the discharge of the nozzle may not be as much from the larger one under a lower pressure, which will do the same work, the net cost of operation is about the same in either case. The trace or clearing path of the high pressure jet is not as broad as the low pressure and less surface is covered per minute. The sand is badly shattered and pulverized under the high pressure and cannot be used as often as when worked under low pressure, more dust is formed, and an examination of the casting under a powerful magnifying glass will show that the surface or skin is indented by the particles of sand, and that some particles are imbedded in the casting, giving it a fine coating of silica which is destructive to cutting tools. On this account a low air pressure is required for aluminum, brass, bronze and other castings of the tin and copper alloys.

High and Low Pressures.

It requires 15.94 horsepower to compress 100 cubic feet of air from atmosphere to 80 pounds pressure, with one-stage compression and 6.28 horsepower to compress the same quantity to 20 pounds pressure. A ¼-inch nozzle under 80 pounds pressure will require 85 cubic feet of free air per minute or $0.85 \times 15.94 = 13.55$ horsepower, and if we reduce from 80 pounds to 20 pounds we can use a ⅜-inch nozzle requiring 69 cubic feet of free air, and $0.69 \times 15.94 = 10.99$ horsepower. A ½-inch nozzle, which will give a quicker cleaning, will require, when the pressure is reduced from 80 pounds to 20 pounds, 123 cubic feet of free air per minute, and $1.23 \times 15.94 = 19.60$ horsepower.

There is no special advantage in cleaning with high pressures, and as they limit the range of the sand blast, they are not entirely desirable. If a separate compressor is not available for sand blasting, the pressure may be cut down by means of a good pressure reducing valve, which has the advantage of allowing any change in the pressure as desired, and the disadvantage of requiring the air to be compressed first to a higher pressure than that at which it is used, implying an additional expense for power. Low pressures do as good work, cost less to produce, allow the use of larger nozzles, cover a greater surface in a given time, are easier upon the operator and are less dangerous and generally to be recommended.

Pressures.

Excellent work can be done in cleaning medium and heavy grade, iron castings under 15 to 20 pounds air pressure; aluminum castings, 10 to 15 pounds, brass, composition or other bronze castings, 15 to 20 pounds, steel castings, 35 to 75 pounds, depending upon whether green or dried sand molds are used and the tenacity of the adhering burnt sand; generally 35 pounds will be sufficient to give a thorough cleaning to steel. For surfacing or frosting finished steel or iron, an air pressure of from 10 to 15 pounds is required and for surfacing brass, bronze and aluminum 5 to 10 pounds, and a fine, white, sharp sand, in grade from No. 40 to No. 100, according to the finish to be obtained.

In considering the question of pressures it should be remembered that the pressures named are those that should be obtained at the sand blast, which can be confirmed by attaching a pressure gage to the sand tank, and that if the air has to be led to any distance from the air compressor and receiver, the delivery pipe should be materially increased to allow for friction, otherwise the pressure will fall off and the action of the sand blast will not be up to requirements. With but little foresight and at a very interesting additional expense, air delivery pipes of ample diameter can be installed up to the sand blast, giving the benefit of the full pressure as well as that of a considerable body of air behind the sand jets.

If the air pipe is long, condensation may take place within it, which if allowed to enter the sand tank would moisten the sand, and care should be taken to remove this either by trapping or by arranging in the piping a U bend, from the bottom of which any condensed water may be drawn off, and by suitably jacketing the main line.

Quantity of Air Required.

The quantity of air required to operate a sand blast is that which the nozzle will deliver under a given pressure, and is very closely approximated in the accompanying table by Cox which, while calculated for a discharge from a round hole in the side of a sheet metal receiver, will be found to give an ample amount of air, allowing for its passing through the sand blast and the line of delivery hose.

Cubic Feet of Free Air per Minute Required for Varying Diameters of Nozzles and Pressures.

Diameter of orifice inches.	Receiver Gage Pressure.																
	2 lbs.	5 lbs.	10 lbs.	15 lbs.	20 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.	45 lbs.	50 lbs.	60 lbs.	70 lbs.	80 lbs.	90 lbs.	100 lbs.	125 lbs.
1/64	0.038	0.0597	0.0842	0.103	0.119	0.133	0.156	0.173	0.19	0.208	0.225	0.26	0.295	0.33	0.364	0.40	0.486
1/32	0.153	0.2420	0.3420	0.418	0.485	0.540	0.632	0.710	0.77	0.843	0.914	1.05	1.190	1.33	1.470	1.61	1.970
1/16	0.647	0.9650	1.3600	1.670	1.930	2.160	2.520	2.800	3.07	3.360	3.640	4.20	4.760	5.32	5.870	6.45	7.850
1/8	2.435	3.8600	5.4500	6.650	7.700	8.600	10.000	11.200	12.27	13.400	14.500	10.80	19.000	21.20	23.500	25.80	31.400
1/4	9.740	15.4000	21.8000	26.700	30.800	34.500	40.000	44.700	49.09	53.800	58.200	67.00	76.000	85.00	94.000	103.00	125.000
3/8	21.950	34.6000	49.0000	60.000	69.000	77.000	90.000	100.000	110.45	121.000	130.000	151.00	171.000	191.00	211.000	231.00	282.000
1/2	39.000	61.6000	87.0000	107.000	123.000	138.000	161.000	179.000	196.35	215.000	232.000	268.00	304.000	340.00	376.000	412.00	502.000
5/8	61.000	96.5000	136.0000	167.000	193.000	216.000	252.000	280.000	306.80	336.000	364.000	420.00	476.000	532.00	587.000	645.00	785.000
3/4	87.600	133.0000	196.0000	240.000	277.000	310.000	362.000	400.000	441.79	482.000	522.000	604.00	685.000	765.00	843.000	925.00	
7/8	119.500	189.0000	267.0000	326.000	378.000	422.000	493.000	550.000	601.32	658.000	710.000	622.00	930.000	1004.00			
1	156.000	247.0000	350.0000	427.000	494.000	550.000	645.000	715.000	785.40	860.000	930.000						
1¼	242.000	384.0000	543.0000	665.000	770.000	860.000	1000.000										
1½	350.000	550.0000	780.0000	960.000													
2	625.000	985.0000															

In calculating the amount of air required, no allowance need be made for sand, for with a proper discharge, that is, one giving the best cutting effect, the actual volume of sand to air delivered will be not over one per cent of the latter.

Air Compressors.

Air compressors are made by various makers, and are so standardized that description here is unnecessary. It is unwise to obtain only just enough capacity to cover present needs, for the use of air is extending, new tools are being added, and if a compressor with a capacity of from 50 to 100 per cent over current estimated requirements is installed, the advantage of having an ample supply of air at hand, and of being able to obtain all needed at a

moderate speed will justify the additional expense of the larger installation and relieve the user of a constant source of worry and annoyance.

An air receiver of ample capacity is especially desirable and gives a backing of volume and pressure to all air tools, besides delivering very dry air.

Moist air is fatal to the operation of any sand blast, the condensation from the interior of the sand tank flowing down to the bottom, moistening the sand about the sand valve and preventing it from flowing. Moisture can always be removed by trapping the air pipe by means of suitable U bends with drip cocks, or by a second receiver, and it is necessary that it be attended to, upon the first indication, if satisfactory work is to be done.

For the same reason an excess of oil in the air cylinders will show quickly in the sand blast and hose, causing the sand to clog and the hose to rot and wear rapidly. A very small quantity of oil is sufficient to keep the air end of the compressor and the pistons and valves of air tools in good order.

Every sand blast should be emptied of all sand at the end of the day's work, for the inner surface of the sand tank will act as a condenser and condense any moisture in the air, causing any sand remaining in it to cake and arch over the sand valve.

The successful operation of the sand blast depends upon an ample supply of dry air at the proper pressure and dry sand of suitable grade. If either the air or the sand is damp, the action of the sand blast will be sluggish and unsatisfactory, if it does not altogether cease.

METHOD OF ASCERTAINING THE LIFTING PRESSURE OF MOLTEN METAL ON CORES

BY F. WEBSTER

CAST iron will sink in water sometimes, but it will float in mercury, which is a liquid metal at ordinary temperatures and 13.6 times heavier than water. These commonly known facts indicate that the relative weights of the substance have something to do with the "sink or swim" performance.

But why does an iron vessel float on water? This phase of the question evidently shows that the weights per cubic foot of the substances do not decide the question, but that the form and volume have something to do also with the making of a "sinker or a floater." A study of two or three simple experiments will enable one to understand the principles involved in the flotation of solids, and how to calculate the weight necessary to hold down a submerged body, such for example, as a core.

Referring to Fig. 1, suppose a cubic foot of cast iron is suspended from the hook of a scale. After recording the weight, which is 450 pounds, lower the block of iron to one-half its depth into a vessel of water, Fig. 2, and note the weight recorded on the scale. This time the weight will be 31¼ pounds less than before, or 450 — 31¼ = 418¾ pounds. Then submerge the block as in Fig. 3, when the scale will record 387½ pounds, or 62½ pounds less then when weighed in air.

Experiments with a Block of Iron.

If the vessel had been brim full of water, the immersion of the iron would have caused one cubic foot, or 62½ pounds, to spill over. The weight of the iron in this case has been taken at 450 pounds per cubic foot, and that of the water 62½ pounds because these weights are about the average values found in practice, and these weights will serve to illustrate the principle without introducing complex data. The experiment with the block of iron shows

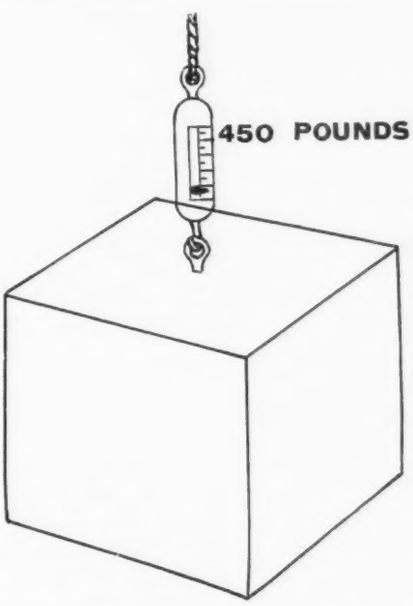


FIG. 1—CUBIC FOOT OF CAST IRON SUSPENDED FROM A SCALE

that a submerged body loses in weight an amount equal to the weight of the volume of liquid displaced.

Instead of a block of iron use a cubic foot of white pine weighing 25 pounds. As this is less than the weight of a cubic foot of water, the block will float as shown in Fig. 4. It sinks into the water, however, until 25 pounds of water are displaced, the depth being 25 ÷ 62½ = 4/10-foot. The experiment with the floating block shows that it displaces a volume of water equal to its own weight. In order to entirely submerge a cubic foot of pine, a pressure of 62½ — 25 = 37½ pounds will be required as shown in Fig. 5.

Pressure on a Green Sand Core.

Suppose, as in Fig. 6, that a green sand core having a volume of one cubic foot, projects 12 inches from the flat surface of the cope. Not only will the submerged core in the molten iron have a tendency to float but there will be an additional lifting effect on the surface of the cope caused by the height of the pouring basin. This action will be understood by referring to Fig. 7, which consists of a closed tank with a vertical piece of pipe about 12 feet long securely fastened in the cover. Assume that the tank and pipe are filled with water; also that the area of the top of the tank is 100 square inches, area of the pipe 1 square inch, and the weight of the water in the pipe five pounds. Then there will be a pressure of five pounds at the bottom of the pipe on the water in the tank. As a liquid transmits pressure equally in all directions, the pressure of the water in the pipe will cause a pressure of five pounds on each square inch of the inner surface of the tank, including the top. Hence, the lifting pressure on the top is 100 × 5 = 500 pounds. It will be seen that the upward pressure depends upon the height of the pipe

and the weight of the liquid per square inch of its area in it, and on the area of the surface in the top of the tank. The actual area of the

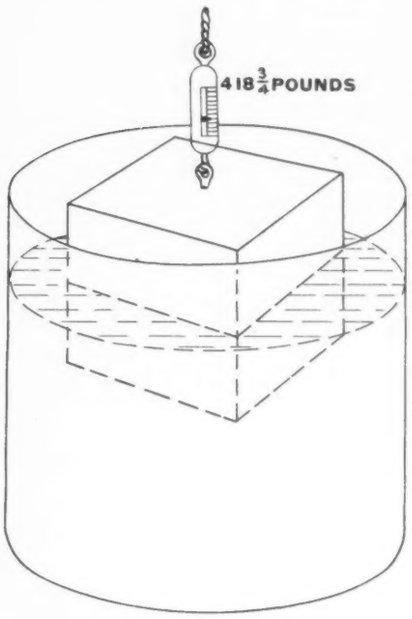


FIG. 2—HALF OF CAST IRON CUBE SUBMERGED IN WATER

pipe does not matter as the pressure will be as great with the use of a small pipe as with a large one.

Lifting Force on the Cope.

The principle explained in connection with Fig. 7 can be used to find the lifting force on the cope shown in Fig. 6. Thus, if the core has an area of 100 square inches at the bot-

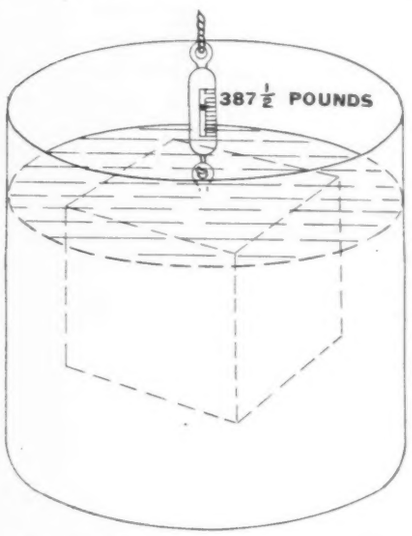


FIG. 3—CAST IRON CUBE ENTIRELY SUBMERGED IN WATER

tom and it is 25 inches from the bottom to the pouring basin, the lifting force is 100 × 25 × 0.26 = 650 pounds. It is necessary to use 0.26 for a multiplier because this is the approximate weight of a cubic inch of cast iron. If the cope at the parting line has 100 square inches in contact with the casting, then the upward pressure on the cope on account of this surface is 100 × 10 × 0.26 = 260 pounds, assuming the cope to be 10 inches deep; that is, the pouring basin is this height above the parting line. The total lifting pressure is 650 + 260 = 910 pounds. Of course the weight of the cope and core of themselves aid in holding the flask together, but it is generally best to allow this extra weight or more as a factor of safety, as in addition to the static pressure of the molten iron, there is liable to be extra pressure caused by the momentum of the flowing metal and by the generation of steam and gas.

Pressure on a Large Core.

An application of the lifting effect of the molten iron on a core is

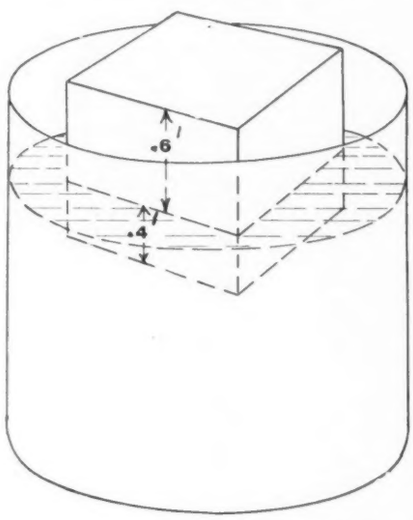


FIG. 4—CUBIC FOOT OF PINE IN VESSEL OF WATER

shown in Fig. 8, where a cylindrical casting is molded on end. The casting is 10 feet long and 4 feet in diameter. The volume of iron displaced by the core is 0.7854 × 4 × 4 × 10 = 125 2/3 cubic feet; and the lifting effect = 125 2/3 × 450 ÷ 2,000 = 28¼ tons. As the weight of the casting is 16.8 tons, it will be seen that the load at A necessary to hold down the core is greater than that of the casting. No allowance has been made for the weight of the core itself, which, of course, aids in keeping it in place. As additional weight above the theoretical amount should be available as a factor of safety, the weight of the core need not always be taken into account.

Pressure on the Mold.

The pressure per square inch on the sand in the bottom of the mold is 120 × 0.26 = 31.2 pounds. In case

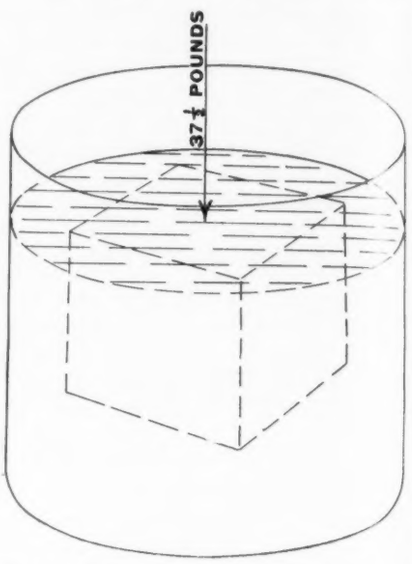


FIG. 5—PRESSURE REQUIRED TO SUBMERGE PINE BLOCK

the casting is 1 inch thick and the thickness of the sand 6 inches, then the inside diameter of the flask will be 60 inches, and the pressure tending to burst the mold at the bottom equals 60 × 31.2 = 1,872 pounds. This force is resisted by the metal of the flask at that ends A and B of any diameter, Fig. 9. There will be a pull of 936 pounds in the ring at A and the same at B, and this force will be applied to a ring 1 inch high at the bottom of the mold. This assumes that all the pressure is resisted by the flask and that the sand has no holding power.

STATISTICS OF FOUNDRY ACCIDENTS.

A circular signed by Thomas D. West, chairman of the committee on the pre-

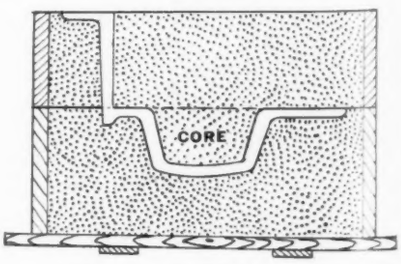


FIG. 6—GREEN SAND CORE 12 INCHES FROM THE FLAT SURFACE OF THE COPE

vention of accidents in foundries, appointed by the American Foundrymen's Association at Toronto, has been sent to all the foundries in the United

States for the purpose of securing data on the number of accidents that occurred during the year from July, 1907, to July, 1908. The circular is accompanied by a blank which foundrymen are requested to fill out and return to Secretary Richard Moldenke, Watchung, N. J. The circular states that the foundry industry offers peculiar opportunities for accidents and consequently proprietors are under an increasing burden in view of the tendency to place all responsibility for accidents upon the employer. The blank classifies accidents under 11 headings, as follows: Personal carelessness, careless work, inattention to surrounding shop conditions, intoxicants, smoking, unavoidable accidents, neglect of safety devices provided, disobedience of orders, taking chances, inferior workmanship or materials used, and ignorance on part of employes. The committee furthermore seeks to ascertain the total number of accidents, average total number of employes during the time specified, number killed or injured through their own fault, number killed or injured through fault of employes, number killed or injured through burns, number killed or injured through bruises, period of greatest number of accidents and amount of accident insurance premiums paid out to cover this time. The information will be considered strictly confidential, and will be used only for compilation of the general report showing statistics of accidents in the foundry industry.

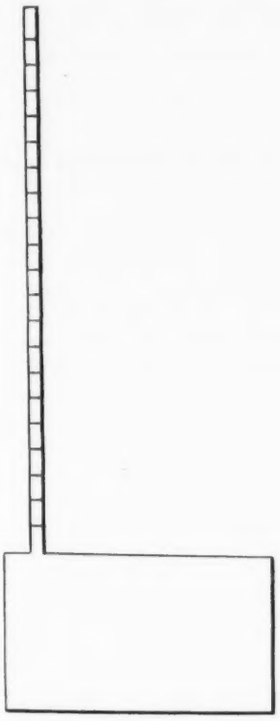


FIG. 7—TANK AND PIPE USED TO DEMONSTRATE LIFTING PRESSURE OF WATER

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The annual meeeting of the Pittsburg Foundrymen's Association was held at the Hotel Henry, Pittsburg, on Oct. 5. The officers for the ensuing year were elected as follows: C. H. Gale, president; Joseph T. Speer, vice president; John M. McLaren, treasurer, and F. H. Zimmers, secretary. The executive committee consists of H. E. Field, John A. Logan, E. D. Frohman, B. D. Fuller and W. A. Johnson. The report of the secretary showed that 30 new members were enrolled during the year, increasing the membership to 102. A. N. Spencer, technical engineer of the Harbison-Walker Refractories Co., Pittsburg, delivered an instructive address on "Fire Brick for Cupolas."

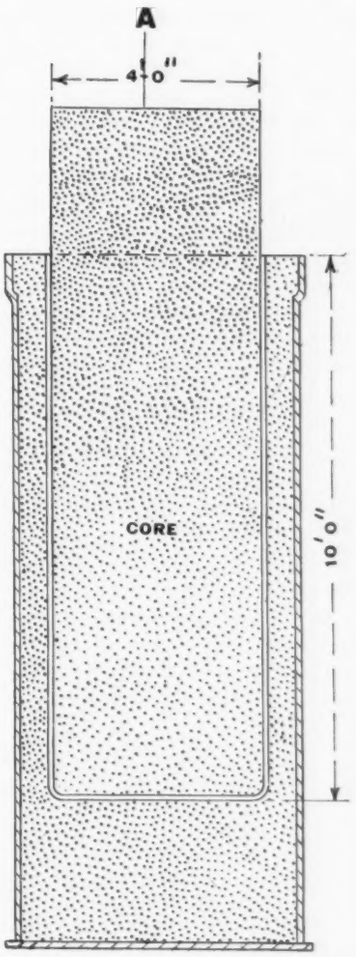


FIG. 8—LARGE CYLINDER MOLD WITH A CORE 4 FEET IN DIAMETER

The subject of a permanent exhibit of foundrymen's appliances in Pittsburg was discussed by H. P. Spilker at the request of J. S. Seaman, who was absent. A committee consisting of H. P. Spilker, E. D. Frohman and F. H. Zimmers was appointed to gather data for such an exhibit.

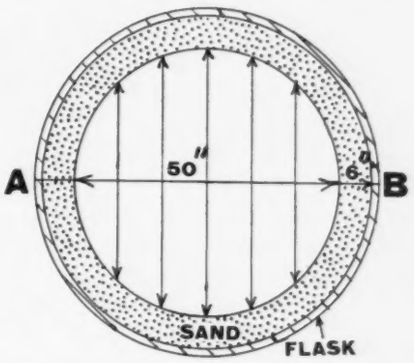


FIG. 9—CROSS SECTION OF CYLINDER MOLD

THE INSTITUTE OF METALS.

The first general meeting of the institute of metals, recently organized in England, will be held in Birmingham, Nov. 11. Papers and communications are expected from a number of scientists, including Dr. Glazebrook, Mr. Rosenhain, A. M. M. Philip, Dr. Hodgkinson and Mr. Robertson. The permanent office of the institute will be in London, probably in the vicinity of the Institution of Mechanical Engineers. A sub-committee has this matter in hand, and it is expected that by the end of November the London office will be opened. The interim council of the institute has appointed G. Shaw Scott permanent secretary.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The fifth annual congress of the International Association for Testing Materials will be held at Copenhagen, Denmark, in 1909. The proceedings will consist chiefly of the official reports of the standing technical committees and individual referees, and non-official papers by members of the association. This meeting will be attended by a large number of foundrymen, as a number of standard specifications will be submitted for final adoption.

PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The October meeting of the Philadelphia Foundrymen's Association was held Wednesday, Oct. 7, at the Manufacturers' Club, Philadelphia. A very interesting paper entitled "A Systematic Inspection and Analysis of Fuels" was read by William S. Gould, president of the Fuel Engineering Co., New York.

A MODEL FOUNDRY ACCOUNTING SYSTEM

Method of recording orders, billing and charging --- Forms for a radiator plant

BY R. W. McDOWELL

WITHIN the last 10 or 15 years great improvements have been made in all departments of foundry accounting methods. The office system has been made to fit the system of the shop and there is just as accurate a record of each department of the plant as there is of the account with any customer. Instead of a hasty inventory taken once or twice a year, stock records are kept which show at frequent intervals the exact quantities of all kinds of material on hand, and systems are operated which give the cost of production of any article or order.

One of the most noticeable improvements that has been made is in the method of recording orders. Formerly it was considered sufficient to send the order or letter from the customer out into the shop and go out after it again when the work was completed. This original order had to serve the purpose of an order, office record and shipping order. Most concerns, however, made a practice of entering these orders in a book for a permanent record, and later began making copies for the various departments of the plant. This was an improvement over the old method, but was still very crude and unsatisfactory. The frequent pen or pencil copies made from the original order offered many opportunities for mistakes, and errors of this kind, if undiscovered, were often expensive, as the order would frequently be found, after it had been completed, to differ more or less from the order sent by the customer.

With the advent of carbon paper for general use in office work, important changes were made in the old methods of entering orders. Systems were devised whereby the office record and the order to the foundry and other departments of the plant were exact copies of each other, and now, by the aid of the billing machines which are coming into common use, it is possible to record an order, make an acknowledgment to the customer, and furnish each department of the plant with an order which must be absolutely correct if checked with the original, as all the copies are made at one writing.

Billing Systems.

The billing systems have also undergone material changes. Instead of making out a bill, copying it in a tissue paper book with a letter press and then entering it in the sales book, the invoice in as many copies as needed, the sales book entry which answers the same purpose as the letter press copy, the shipping order and the bill of lading are all made out at one writing. This saves considerable time, and prevents effectually the very serious and expensive mistake of allowing a bill to go out with no record of it remaining in the office—a frequent occurrence under the old system.

It is also possible in some lines of business to fill out the complete set of order forms, together with the bill, sales book entry, etc., at the same time at one writing, with no extra labor other than adding the date and amounts to the invoice, etc., when it is ready to be sent out, but this can only be done when all orders are shipped complete and is not applicable to the ordinary foundry business.

The two systems described herewith, the order and billing and charging systems, are designed for operation with a book typewriter, but if there is no such machine in the office where they are to be used, may be operated by means of a hard lead pencil with a metal plate to be slipped in below the last copy. This will give fair copies, though not as legible as the machine copies. The ordinary typewriter could also be used for work of this nature if there

THE M. J. RADIATOR COMPANY.

_____, PA.

Sold to Jeffries Heating Co., Date August 15, 1907 Order Number 2364

Address Pittsburg, Pa. Route P.R.R. Customer's No. 678

Ship to Same, When October 20, 1907 Requisition

Address Swissvale, Pa. J.T. Roden, 8th St. Terms 2% 10 days, net 60 F.O.B. cars at _____, Pa.

Number Pcs.	Number Sec.	Size	Number Col.	Style Radiator	Tapping	Total Sec	Total Feet	Price per Ft.	Exten.	Total Amount
12	8	38"	3	Renova, Steam	1-½ x 1-½	96	576			
7	14	38"	3	" "	1-3/4 x 1-3/4	98	588			
10										
		38"		Bremar "			96			
20	6	38"	2	" "	1"	120	480			
							4486	.00	0000 00	
						Less	60-10-7½		000 00	000 00

The Foundry

FORM 1—OFFICE COPY OF ORDER

THE M. J. RADIATOR COMPANY.

_____, Pa., August 29, 1907

Sold to Jeffries Heating Company, Order No. 2364
Address Pittsburg, Pa. Your No. 678
Shipped Same, % J.T. Roden, Swissvale, Pa. Bill No. 3411
Route P. R. R. Car No. 45 632 Initial P. R. R. Terms 2% 10 days, 60 net

Number Pcs.	Sec	Size	Col	Kind	Style	Tapped	Total Sec.	Total Feet	Weight	Price	Discounts	Extensions	Amount	Forward	LF
12	8	38"	3	St.	Renova	1-½x1-½	96	576	4032						
20	6	38"	3	"	"	1/4x 1"	120	480	6 3360	.00	60-10-7/½	0000 00			
								4486	31402			000 00	000 00	000 00	

The Foundry

FORM 2—INVOICE

are not to be more than six copies of the order. The book typewriter or billing machine, however, is far superior to either of the other methods.

Forms of Radiator Plant.

The illustrations shown are for the use of a radiator plant, but are prepared that they can be easily adapted to almost any line of foundry work by changing the number of the columns and the headings of the same. The set of order blanks will be taken up first. For the ordinary foundry there should be an order copy for each department, each copy being of the same color as the other forms commonly in use by that department. The regular set of order forms for a radiator works should be as follows:

1—Office copy of order, Form 1.

2—Acknowledgment to customer. The same as Form 1, with a footnote similar to the following:

"We acknowledge, with thanks, receipt of the above order which we have entered exactly as shown and will ship at the time specified, subject to delays from fires, strikes, accidents or other causes unavoidable or beyond our control."

3—Foundry order. Same as Form 1, except that money columns are omitted, the space being utilized for remarks, etc.

4—Copy to testing department. Same as foundry order.

5—Copy to assembling department, same as foundry order, with columns for checking.

6—Copy to shipping department, same as foundry order, with columns for checking.

7—Copy to stock room, same as foundry order, with columns for checking.

Only the office copy is shown as they are all practically the same, the only difference being the omission of the "Prices," "Extensions," and "Total Amount" columns on the majority of the forms. Short carbons are used with these forms so that these spaces may be left blank. When an order is received, a set of these forms is placed on the machine and the order entered. It is then checked to insure accuracy. The original order is then filed in an order file, preferably a file arranged on the vertical plan, the acknowledgement mailed to the customer, and the office copy filed in a binder labeled "Unfinished Orders." The copies are then distributed through the various departments.

The foundry foreman is particularly benefited by this arrangement, as by going over the orders he has on hand he knows exactly what kind of radiator to manufacture, and is in no danger of stocking up on some particular kind or class of radiator which might not be needed for months ahead. The time the order has been promised shows up on each order

THE M. J. RADIATOR COMPANY

----------, Pa., August 29, 1907

Sold to Jeffries Heating Company, Order No. 2364
Address Pittsburg, Pa. Your No. 678
Shipped Same, % J.T. Roden, Swissvala, Pa. Bill No. 3411
Route P. R. R. Car No. 45 632 Initial P. R. R. Terms 2% 10 days, 60 net

Number Pcs.	Sec	Size	Col	Kind	Style	Tapped	Total Sec.	Total Feet	Weight	Ck.	Checked by	No Shipped	Balance
12	8	38"	3	St.	Renova	1-½x1-½	96	576	4032				
20	6	38"	3	"	"	1/4x 1"	120	480	6 3360				
								4486	31402				

The Foundry

FORM 3—STOCK ROOM SHEET

THE M. J. RADIATOR COMPANY.

_____, Pa., August 29, 1907

Sold to Jeffries Heating Company, Order No. 2364

Address Pittsburg, Pa. Your No. 678

Shipped Same, % J.T. Roden, Swissvale, Pa. Bill No. 3411

Route P. R. R. Car No. 45 632 Initial P. R. R. Terms 2% 10 days, 60 net

Number Pcs.	Sec	Size	Col	Kind	Style	Tapped	Total Sec.	Total Feet	Weight	Price	Discounts	Extensions		Amount	
12	8	38"	3	St.	Renova	1-½x1-½	96	576	4032						
					"				6						
20	6	38"	3	"	"	1/4x 1"	120	480	3360	.00	60-10-7/½	0000	00		
								4486	31402			000	00	000	00

The Foundry

FORM 4—SALES BOOK SHEET

copy, so all departments know just what to get out first. Special instructions to any department may be noted on the copy going to that department.

As each department completes its part of the order, it returns its order copy to the office, and when the order from the shipping department comes in correctly checked by the inspector, the office copy is transferred to another binder labeled "Finished Orders." The original order is then marked "Shipped," together with the date of shipment. This disposes of the order, with the exception of making out the invoice, and this operation brings out the other set of forms, namely, the bill and charge system.

Bill and Charge System.

The forms of this set are as follows:

1—Invoice, Form 2. This can be made in duplicate or triplicate if so desired.

2—Stock room sheet, Form 3. Same as the invoice, price columns omitted.

3—Sales book sheet, Form 4. Same as the invoice, except that it contains one extra column, and is of sufficient length to accommodate several invoices.

4—Bill of lading, Form 5. This may be made in triplicate or quadruplicate.

These forms are made out on the machine in exactly the same manner as the order forms, short carbons being used wherever it is desirable to omit the prices. The invoice contains the same general information that is shown on the order, being arranged in a slightly different form. The stock room sheet has the prices omitted, the space thus left being taken up with columns for check, by whom checked, number shipped, and balance, these last two columns being only used in case of a partial shipment.

The sales book sheet is made as long as can conveniently be handled and is filed in a special loose leaf binder, from which the postings are made to the ledger in the manner of a regular bound sales book. The bill of lading is the usual form, but is made so that the headings and the weight columns come directly under the heading and weight columns on the other forms. In this way there is only one operation in place of the old method of first making out the invoice, then making out the bill of lading (each copy being an original) then copying the invoice with a letter press and finally making the entry in the sales book. By the old method there were at least four chances for mistakes, besides the danger referred to above, that of bills going out without a corresponding charge in the books. By this method there is no chance for a mistake if the invoice is correctly made out, and the double checked order is always at hand as proof as the copies must all be the same. Besides this, the work is done in about one-fourth of the time, and is much neater and more legible.

There is, of course, some chance for error in either of these systems. But it will be found that after they have been in use for a short time that there will not be more than 15 per cent of the mistakes made that there were under the old style. And it is certainly far better to provide the foremen and all departments with clear, legible and accurate instructions as to what is required of them on various orders than to send out a poorly written and hurried order copy.

COPY

Received from M. J. Radiator Co.

In apparent good order, except as noted, the packages described below (contents and value unknown), marked and consigned as indicated, which said company agrees to transport with as reasonable despatch as its general business will permit, to destination, if on its road, or otherwise to the place on its road where same is to be delivered to any connecting carrier, and there delivered to the consignee or to such connecting carrier, upon the terms and conditions on back hereof.

_____, Pa., August 29, 1907

Sold to Jeffries Heating Company,

Marked Pittsburg, Pa.

Shipped Same, % J.T. Roden, Swissvale, Pa.

Routed P. R. R. Car No. 45 632 Initial P. R. R.

	DESCRIPTION OF ARTICLES								GROSS WEIGHT
12	8	38"	3	St..	Renova	1-½x1-½	96	576	4032
					"				6
20	6	38"	3	"	"	1"	120	480	3360
								4486	31402

The Foundry

FORM 5—BILL OF LADING

FIGURING THE WEIGHT OF CAST STEEL

Method of ascertaining the weight of steel castings, green and dry sand, annealed and unannealed

BY R. A. BULL

HARMONIZING the estimated with the actual weight of steel castings has at times been something of a problem to the writer, and his experience has doubtless been paralleled by other steel founders. Frequently it is essential that the actual weight of castings shall not exceed the estimated weight by more than a very narrow margin. If such a casting weighs more than the estimate, plus the permissible variation, and has no swells, strains, or other obvious imperfections to account for the surplus weight, the average foundryman with, it must be said, some satisfaction, seizes the opportunity to criticise the accuracy of the engineers' figures, and occasionally his criticisms are well founded. On certain classes of work, the contract may call for penalizing the manufacturer for over weight. Then the method of arriving at the estimated weight should be given consideration.

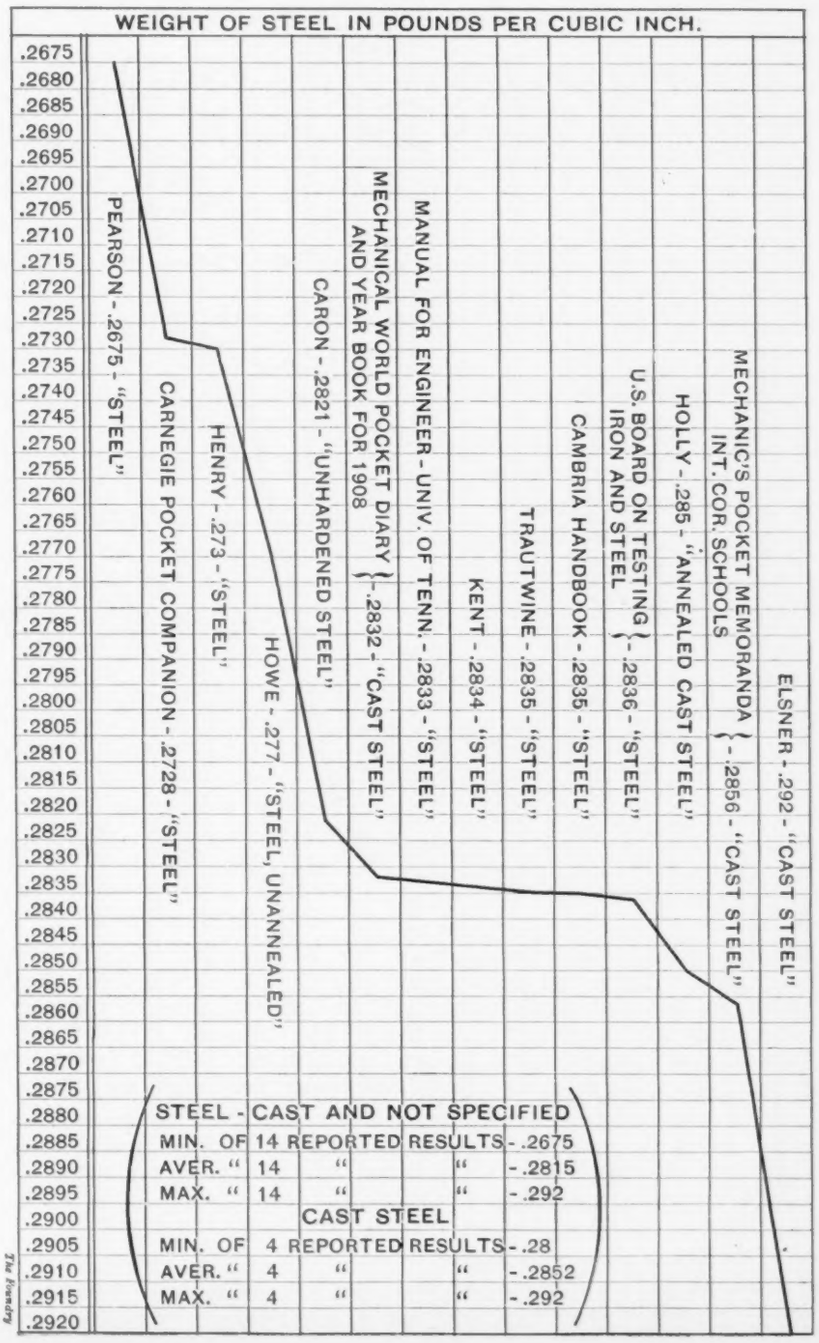
With simple appliances, proper care and a little time, the average specific gravity from several representative specimens may be obtained, and the weight computed therefrom. It often happens, however, in the rush of breaking tonnage records, that such determinations are not made, and that hand-book tables are accepted without question. Using some such figure as a base, it becomes a matter for close observation and experience to decide on the percentage to allow for fillets, expected casting irregularities, and in some cases, adhering sand on rough green sand work, particularly box sections where it is not necessary to thoroughly clean the castings, if sold by the piece.

Comparison of Results.

There are not many authorities who have reported the specific gravity or weight of cast steel, and there is a wide range covering the published results on steel generally. Table I may be interesting as a comparison of some of these.

Some of the sources from which the figures in Table I are taken are not quoted as giving their results in weight in pounds per cubic inch, several finding the weight per cubic foot, and a few simply reporting the specific gravity. Where minimum and maximum have been given I have struck an average, and have resolved all into weight in pounds per cubic inch, purposely taking the specific gravity wherever shown, and calculating 62.36 pounds of water per cubic

Table I.



inch at 62 degrees Fahr., which Prof. Kent accepts as a fair figure, being the average of several investigators. Several well-known publications besides those given in Table I, such as Jones & Laughlin's Hand Book, report 0.2835 pounds per cubic inch, but it is fair to assume that they may be quoted from Trautwine.

Finding such a variation in the results reported from various sources, and so few on cast steel, the writer made his own determinations, concerning which a detailed report may be of assistance to some of his colleagues. One specific location was selected on each of eight castings for cutting section, all sections cut were used, and are here reported. All specimens were polished, any surface cavities were filled with paraffine, and they were lowered by a fine silk thread into water and the displacement carefully noted. The weighing was done on an Eimer & Amend No. 5393A balance. The water was at a temperature of 15 degrees Cent. or 59 degrees Fahr., within three degrees Fahr. of the standard figure, and too close to it to necessitate any change in the results. Table II is self-explanatory, and the analyses are given to further enlighten any inquirers who may have found different results. It is interesting to note the influence of location, as well as moisture, on the density of the specimens.

It will be observed that the minimum and average of the reported results on cast steel are higher than those quoted for steel generally in Table I. This may only be a coincidence, or it may confirm Prof. Howe's observations that the density of unforged steel castings is surprisingly high. He possibly came to this conclusion by comparing cast with rolled steel, and finding that the reduction of volume due to small blow holes did not lower the specific gravity in direct proportion. A logical explanation is that the density of the metal immediately surrounding the cavities is greater than normal, being solidified under compression. Of course, to what extent this affects the total specific gravity depends on the size of the blow holes.

Table II.

WEIGHT AND SPECIFIC GRAVITY OF UNANNEALED CAST STEEL

SPECIMEN No.	NATURE OF MOULD	VERTICAL POSITION OF SPECIMEN IN FLASK	PHYSICAL CHARACTERISTICS OF SPECIMEN	SPECIFIC GRAVITY	POUNDS PER CU. FT.	POUNDS PER CU. IN.	CHEMICAL ANALYSIS
1	ENTIRELY OF DRY CORES	BOTTOM OF DRAG	HOMOGENEOUS	7.856	489.94	.28353	C. .18 P. .014 S. .024 Mn. .76 Si. .32
2	GREEN SAND NOT SKIN-DRYED NO CORES	MIDWAY BETWEEN COPE & DRAG	SMALL BLOW-HOLES	7.669	478.28	.27678	UNKNOWN
3	SAME AS No. 2	SAME AS No. 2	SAME AS No. 2	7.503	467.91	.27078	UNKNOWN
4	SAME AS Nos. 2 AND 3	SAME AS Nos. 2 AND 3	SAME AS Nos. 2 AND 3	7.395	461.14	.26686	UNKNOWN
5	GREEN SAND SKIN-DRYED WITH NUMEROUS DRY CORES	BOTTOM OF DRAG	MINUTE BLOW-HOLES	7.720	481.45	.27861	C. .19 P. .013 S. .023 Mn. .73 Si. .33
6	GREEN SAND NOT SKIN-DRYED	TOP OF COPE	ONE MINUTE BLOW-HOLE	7.818	487.54	.28214	C. .18 P. .014 S. .024 Mn. .71 Si. .35
7	GREEN SAND NOT SKIN-DRYED WITH NUMEROUS DRY CORES	TOP OF DRAG	HOMOGENEOUS	7.858	490.02	.28358	C. .22 P. .011 S. .024 Mn. .74 Si. .32
8	SAME AS No. 7	BOTTOM OF COPE	HOMOGENEOUS	7.797	486.22	.28138	C. .19 P. .011 S. .024 Mn. .70 Si. .32
AVERAGE LAST COLUMN SHOWS AVERAGE OF ANALYSES OF ALL HEATS FOR ONE MONTH'S RUN.				7.702	480.29	.27795	C. .20 P. .014 S. .021 Mn. .76 Si. .33

The Foundry

Specific Gravity.

It is known that steel decreases in weight as the carbon increases. Prof. Howe finds it "probable to judge that density decreases * * * with rising carbon content * * * at about the rate of 0.06 (specific gravity) per 1 per cent increase of carbon content." Other elements also affect the specific gravity, as annealing, which raises it, and quenching, which lowers it.

Prof. Howe found that the average "raw" steel has a specific gravity of 7.7, and the average annealed, 7.845. This is an increase of 1.88 per cent, making annealing the most important factor to consider in practice. As all metallurgists accept Prof. Howe's results without question, I have deemed it time lost to anneal my specimens and make another set of determinations.

Results of Observations.

Basing our conclusions on the knowledge derived from Table II, and on Prof. Howe's findings as to the effect of annealing, it would seem advisable to recommend:

First, that for the general run of work in foundries making what we may call ordinary steel, having a mixture of green and dry sand work, the figure 0.278 be used for unannealed, and 0.283 for annealed.

Second, that for exclusively dry sand castings, 0.283 be taken as the base figure for unannealed, and 0.288 for annealed.

Third, that 0.275 be accepted as the decimal to use for exclusively green sand work, not skin-dried and not annealed, and 0.28 for the same, annealed.

Fourth, that the above recommended figures be applied to "mild" or soft steel castings, and that for steel of much higher carbon content, they be reduced in accordance with Prof. Howe's findings, quoted in the preceding, or at the rate of four-fifths of 1 per cent for each per cent increase of carbon.

Having decided upon a base figure, great discretion should be used in the percentage to add for fillets, etc. This should be governed largely by the nature of the casting, but for the average run of work, 10 per cent will be found fair, and with good shop practice and proper flask and pattern equipment, the foundry should keep within 3 per cent of the final figure.

CHICAGO AND MILWAUKEE FOUNDRYMEN VISIT GARY.

On Saturday, Oct. 10, the Milwaukee Association of Foundry Foremen was the guest of the Chicago Foundry Foremen's Association. The visitors, numbering close to 100, upon their arrival were taken on a trip through the underground traffic tunnel of the Illinois Tunnel Co. After luncheon was served the entire party, including about 175 foundrymen from Chicago, boarded a five-car special train for Gary, Ind., where the new plant of the United States Steel Corporation was inspected. In the evening the foundrymen were tendered a banquet.

THE PURCHASE OF MOLDING MACHINES

Pertinent suggestions which the foundryman should consider when selecting this labor saving equipment

BY R. V. NOTBUR

SOONER or later every foundry manager will be confronted with the question, "Is there anything in machine molding for me?" The question may arise from two sources; a desire to reduce costs to increase profits, or the fact that competition forces cost reduction by making low prices. From the intense interest that centers around the exhibits of molding machines at foundry exhibits it is perfectly clear that this is a burning question in the minds of thoughtful men who are determined to make every dollar they can out of their foundries.

In dealing with the subject there are many things to be considered. It must be settled beyond all doubt that the casting under consideration can be made by machinery. If it can be made, it must be determined that the saving in labor, increase in output and a larger quantity of perfect castings, will pay a sufficient return on the money invested in the machine and equipment. The rapid development of the molding machine during the past five years has made it possible to produce molds by machinery for almost all castings that are made in two part flasks.

Considering the Purchase of Molding Machines.

In considering the production of a certain casting by machinery, if there is any doubt whatever about its being successfully made, the manufacturer of molding machines should be consulted. Every responsible manufacturer of molding machines understands that the reputation of his product depends upon the accuracy of his judgment on this point and his opinion should have great weight. Granting that a certain casting can be made on a molding machine, the next question to decide is whether it will pay to make it in this way.

Economies of Machine Practice.

Every practical man will admit that a machine is more accurate in duplicating work than a human being. Take for example the process of drawing patterns from the mold. It is a fact that no two molders exert the same energy in rapping a pattern by hand when it is being drawn from the mold. In other words, if two molders are producing work from patterns that are exactly alike in every measurement there will be a variation in the size of the castings which they produce. With castings that are to be fitted, this is an important matter. A machine-made mold on the other hand is always the same size, granting that the machines are correctly operated. This is a very important advantage in favor of the machines and one that is often overlooked. In some cases the saving in the machining of castings made necessary by variation, will alone pay for the installation of the molding machine. The writer knows of one case where a brass foundry saved 30,000 pounds of metal in overweights by the use of a molding machine, on one job running for about a year.

Losses Reduced.

Theoretically, the mechanical making of molds should remove the subject of discounts from consideration, but it is a fact that there are bound to be imperfect castings in a day's run of a molding machine. It may be said truthfully, however, that these are caused more from careless handling of the completed molds than from the failure of the machine to do its work. A searching examination into this one point shows that machine molding reduces discounts to a point where the economy thus effected pays a liberal rate on the investment.

Coming to the actual output of the molding machine on a certain casting, it must be frankly stated that it is very seldom that this can be exactly determined before the machine is operated in the foundry where it is to be used, but an estimate can be made by one experienced in machine molding which will be accurate enough for all practical purposes.

Output.

The manufacturer of molding machines is constantly in touch with results secured by this method of molding and his experience should enable him to give anyone interested a conservatively estimated output of a certain casting made under average conditions. Of course, he cannot run the foundry where the machine is to be used nor select the machine operators, but he knows what his machine will do when properly used and should be given the credit of having wider practical knowledge of the subject than anyone else can have.

It is to his advantage to underestimate rather than overestimate the machine's output, because if he estimated the output at 25 molds per hour and the user gets 30 molds, the molding machine manufacturer can always count on an enthusiastic user which, to the far sighted business man, is one of his best selling assets.

Attitude of the Manufacturer.

If one who is interested in this subject will approach the manufacturer in the spirit of co-operation rather than one of antagonism, the general use of molding machines would be widely extended. The experience of the manufacturers of machines of this kind should certainly convince them that it would be poor judgment for them to deliberately make misstatements in order to sell their products, for they must realize that the increase in output is only one element in the advantage of machine molding.

In writing this we are assuming that the party who is contemplating the purchase of a molding machine is not acquainted by actual observation with the splendid results that are being obtained by their use. To his reproach it must be added that there is hardly a large foundry center in the country that does not now have some plant producing molds by machinery where the opportunity for personal investigation is very convenient.

Estimating the Savings Effected.

After the figures have been obtained on all of the points covered thus far, it is then necessary to determine whether the total saving will be large enough to warrant the capital invested in the ma-

chine. The most accurate and simple method is to keep a record of a journeyman molder producing the casting under consideration; determine an average day's output of castings; the average number of imperfect castings that appear during the same space of time, and also keep a record of the machine work required to overcome castings that are made overweight. Compare this with the machine molding results as estimated by the manufacturer of the machine or with actual results of users of machines in a corresponding line of work.

In considering the result of machine molding it is safe to practically eliminate the item of variation in castings entirely and in calculating the discounts in machine molding it is safe to place this below 5 per cent of the total output. It is safe to say that such calculation will result in an enormous saving by machine molding.

When the economy is calculated, the price of equipment should be considered and the percentage of return on the investment should be determined.

Pattern Expense.

There is one feature of machine molding that has not been covered thus far and that is the saving in pattern expense. The majority of molding machines now in use are equipped with pattern plates which are not subject to the damage that comes to gated patterns used with sand matches or followboards. This is an important detail.

It is astonishing that there are hundreds of foundries in this country to whom the expense of installing molding machines is not a consideration, who have totally ignored the innovation that machine molding has made in foundry economy. They are spending large sums of money in elaborate cost departments and have difficulty in understanding how their competitors produce competitive articles at such low prices. When it is considered that in many instances, molding machines have effected savings amounting to as much as $10 per day on every machine in use, or $3,000 per year, the reason for their inactivity along this line becomes more perplexing.

Relation of Molding Machine to Foundry Practice.

The molding machine in the foundry bears the same relation to foundry practice that the typesetting machine bears to the printing trade, and the factory that is making large quantities of castings by hand that can be made by machinery is at the same disadvantage that the typesetter is in competing with the linotype operator.

The molding machine has not only come to stay, but it has been here for some years, and the best evidence of this statement will, on investigation, be found in the fact that the foundries that are making the most money and supplying the largest percentage of the world's consumption in their own lines are, and have been for some years past, using molding machines.

METHOD OF OBTAINING A UNIFORM CHILL IN CAST IRON ROLLS*

BY THOMAS D. WEST

THE determination by actual test of the difference in strength of turned, chill and sand cast rolls of like diameters, both cast from the same ladle of metal, would be very valuable to engineers and manufacturers. So far as the writer is aware, no such tests have been made. It is reasonable to expect, however, that the strength of the sand cast roll will exceed that of the chill roll, if both are cast from the same metal, especially if there should be any variation in the thickness of the chill. This view will doubtless be shared by those who have had extended experience in the use of chill rolls.

In casting a chill roll the general conditions are as shown in Fig. 1. The metal in the outer part a, will present a white appearance for a depth of ¼ to 2 inches or more, while that in the necks and body, b and c, will be mottled or nearly gray. In a the carbon exists in the combined form, while in b and c it is largely graphitic. The fact that the shrinkage of the former in solidifying is considerably greater than that of the latter is an important factor in the manufacture of rolls. If two test bars, under 2 inches square in section, are cast from the same ladle, the one in an iron, the other in a sand mold, the contraction of the former will be about twice that of the latter.

When a chill roll mold is being filled with metal the cooling qualities of the chill d, Fig. 2, causes the outer body of the inflowing metal, as it comes in contact with the chill face e, to solidify so rapidly that a contraction crust is formed in two to five minutes according to the diameter of the roll.

Formation of Sustaining Crust.

The formation of the sustaining crust is easily explained. On the side e, Fig. 2, the metal is shown as it fills the mold, while on the opposite side f, the conditions that exist two to five minutes after the roll is cast are indicated. It is seen that the chill d has ceased to offer any support to the crust a by reason of the space created at x and that the chill d might be removed, so far as the body of the roll is concerned, if that were practicable. It is also evident that the metal inside of the crust a and the necks of the rolls is still in almost as hot and liquid a condition as when first poured. Its fluidity may, in fact, be maintained for 20 to 60 or more minutes, according to the size of the roll. This condition serves to explain in large part the difficulty of obtaining satisfactory chill rolls. The thin, almost semi-molten crust, a, must sustain, during the early period of the operation, the static pressure of the confined liquid metal. The result in obtaining a chill roll casting is affected by small variations in the level of the mold, the quality of the metal, the temperature in pouring, the catching of fins at joints or crevices in the face of the chill, the operation of feeding devices, etc. It is no wonder, therefore, that with a process so sensitive and difficult to regulate, that the losses range from 10 to 30 per cent of the nominal output by the systems now in use, and that the rolls cast in this manner are rarely circular with a uniform thickness of chill.

Movable Chill.

For the successful casting of chill rolls the appliance should be such as to enable the chill d to remain con-

*Presented at the annual meeting of the American Society for Testing Materials.

stantly in intimate contact with the crust a, and that it be controllable likewise vertically to take care of the contraction in that direction. Numerous devices designed to overcome the evil effects of a contracting crust have been tried, but none of these meet the requirements in anything like the same measure as the appliance represented in Fig. 3, which differs radically from anything previously attempted, and is the invention of the author's son, Ralph H. West, who has had considerable experience in the manufacture of chill rolls.

In the use of this device, the action of the contracting crust was demonstrated in a way never done before, and it served to show what may be accomplished to insure a circular roll casting of uniform thickness of chill. To make this clear a detailed description of the operation will first be presented.

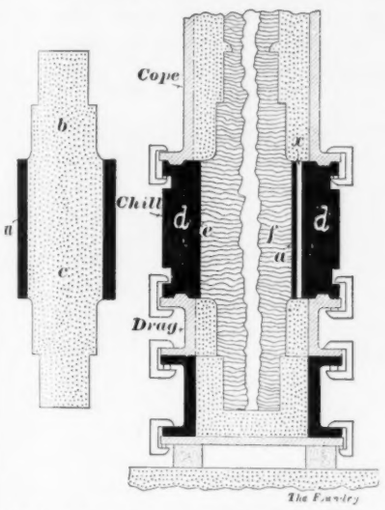


FIG. 1—SECTION OF ROLL AND CHILL

FIG. 2 — SECTION OF ROLL MOLD SHOWING CRUST FORMATION SOON AFTER COOLING

New Device.

The chill d, Fig. 3, has grooves t, which are shown in an exaggerated form in the illustration. These grooves vary in height and number to suit varying requirements, and exhibit gradual variations from bottom to top in the inclination of the sloping surfaces h and j, for the purpose of taking care of the vertical contraction of the solidifying crust. This serves to insure a close contact between the upper slope of every groove and the corresponding bead cast on the chill roll during the entire period of settlement to final rest, which is brought about in the following manner.

After the metal is poured through the swirl gate k, the band l, operated by a lever, not shown, is moved, which serves to bring holes in the band to positions opposite m, this action allowing fine sand and other flowable material to run out of the partitions n and p, at any desired speed. The chill d is lowered by this action causing the sloping surfaces h and j to remain in intimate contact with the upper sloping surfaces of the beads cast on the chilled surfaces of the roll.

First Roll Cast.

In the first roll cast by this device the chill commenced to settle in about two minutes after the pouring was finished, and in about seven minutes the grooved face r had slid over the bead face i thus giving direct indication of the internal action of the contracting chill crust, a matter never before accomplished.

In this device the outer diameter at the points i, is such that when the roll is cold enough to be removed from the chill it can be hoisted out of the latter, or the latter off the roll, as may be desired. The body of the sample roll cast in this chill was 11 inches in diameter and 14 inches long. When put in the lathe to be turned it was found to be perfectly round and of an exact thickness of chill at all points of its circumference.

Other Devices.

Five other devices differing in the form of the grooves and the method of insuring contact have been designed. In one case the chill remains stationary while the cope, casting and drag can be lowered. In another the crust is depressed. In a third the cope and casting settle into the drag, while the chill remains stationary. In some of these devices the grooves, or hugging faces, are so arranged that they remain in constant contact with the beads on the roll until the latter is removed from the chill or its molds.

Roll turners claim that the extra labor in turning up chill rolls to remove the slight projections or beads cast on the rolls by this system is, on the average, much less expensive than that required to turn up smooth-faced chill rolls that are not circular.

Referring to Fig. 3, the cope is supported from the drag independent of the chill by means of four wrought iron tubes s, bolts t, adjustable sleeves u, and set screws v. Three or four long turned rods or pins w serve to center the chill and cope with the drag.

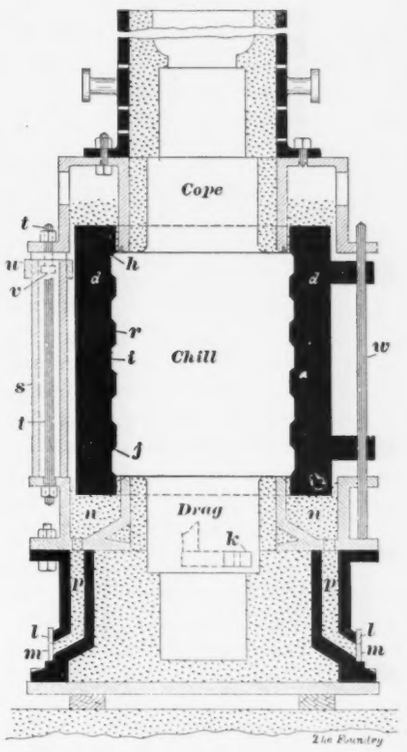


FIG. 3—IMPROVED CHILL SHOWING METHOD BY WHICH IT IS MAINTAINED IN CLOSE CONTACT WITH THE SHRINKING METAL

THE ELECTRICAL RESISTANCE OF METALS.

Commenting on the electrical conductivity of metals and alloys, W. Guertler in *Metallurgie*, divides metals and alloys used for conductors into two classes, first, those which are difficult to melt, including iron, nickel, copper, silver and gold, and, second, those which are easily melted, including magnesium, aluminum, zinc, tin, lead, antimony and bismuth. Observations of the properties of alloys of these metals with each other, as well as with the non-metallic elements like carbon, silicon and phosphorus, indicates that search for a new metallic conductor of a conductivity approaching that of copper or silver, must necessarily be fruitless. The only possibility is that a conductor might be discovered which, with the least possible diminution of conductivity, would exhibit the greatest improvement in mechanical or chemical properties.

Alloys for resistances, in which the temperature coefficient must be as small as possible can only be found among those consisting chiefly of metals of the first group. The field for investigation here, however, is practically unlimited.

THE PROFIT EARNING CASTING PLANT

Economies that can be effected in periods of depression that will insure dividends despite restricted demand

BY H. COLE ESTEP

A PERIOD of intense industrial activity is always accompanied by lax shop methods; orders are piling up so much faster than they can be filled that everything is sacrificed to rapidity of production. Money is received in a steady stream; what matters it if the outgoing stream is five or even ten per cent larger than rigid economy would allow? But later comes a business depression. It is then that the wise manager, instead of disorganizing his plant by headlong, unguided retrenchment, will take up the slack in the expense account by careful attention to the details of production, redesigning and reorganizing his shop until all the little leaks that mark the difference between profit and loss in dull times, are effectually checked.

The Flask Yard.

I have seen foundries elaborately provided with cranes, hoists and other transportation facilities inside, which, however, ceased abruptly at the shop door. The result was that the flasks, heavy and light, which were usually heaped in some out of the way corner of the yard, had to be handled entirely by the most primitive methods. If a heavy flask were required in the shop eight men would be sent to the flask yard to carry it in on their shoulders, first the cope, followed by the drag. These men would be diverted from their regular work a full half hour. The same wasteful process would be repeated when the flask was returned.

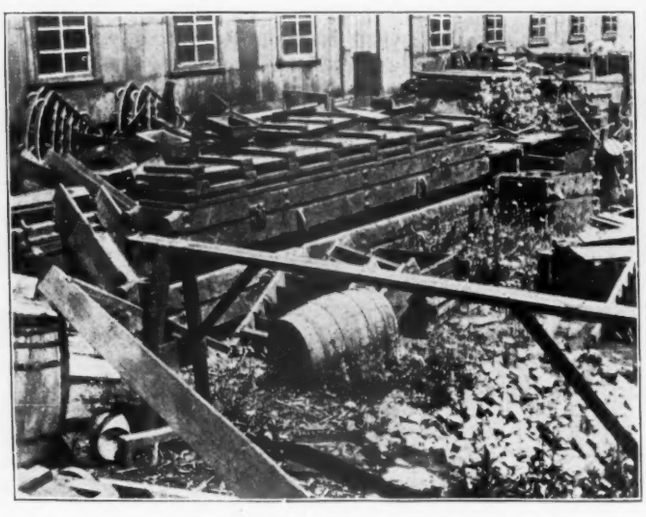
At nominal wages (20 cents an hour) the cost of moving the flask in and out of the shop each time was $1.60. This single act alone was repeated at least 50 times a year, so that the annual cost of moving one heavy flask to and fro was $80, which represents the interest at 6 per cent on an investment of $1,333. Going one step further we find that a light tramway of scrap rails, a home-made car and a wooden boom derrick which would reach every part of the yard and make it possible for one, or two men at the most, to move every flask would cost $200 or less. With this rig, allowing two men's time for one hour at each move, it would cost, including interest, $32 to move our heavy flask 50 times a year. This represents a saving of $48 per annum in one item alone. In dull times profit making management demands that just such saving be effected.

Crane Equipment.

Most modern shops are well equipped with cranes. Except in a few far western plants which have yet to see the necessity for rigid economy, traveling cranes are used almost exclusively. Yet, even in the best shops, we will frequently find a group of men sitting around killing time waiting for the crane to come to their floor. Often a few light, cheaply constructed jib cranes properly located and used as supplements to the main traveler will make much of this time-killing and its consequent loss unnecessary.

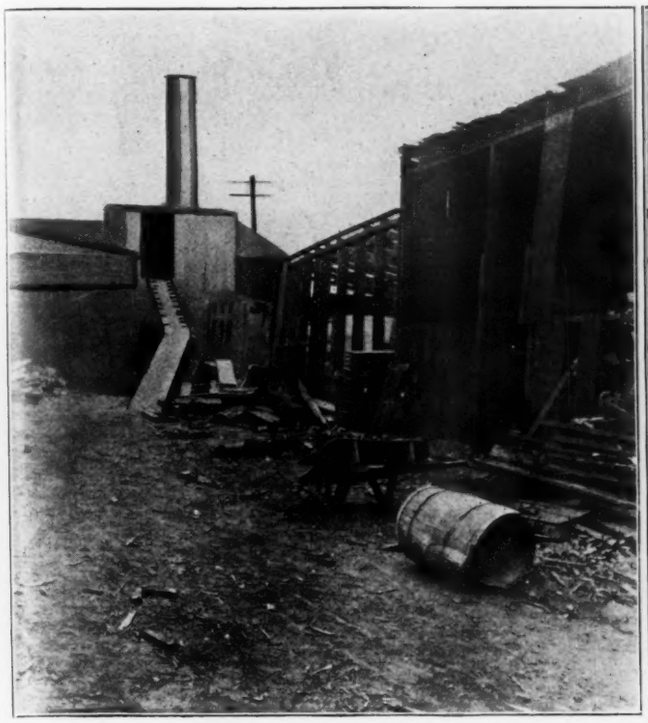
Handling Pig Iron.

To pay a man, when it can possibly be avoided, for preforming purely mechanical service such as wheeling pig iron, is in nearly every case the worst kind of economy. A charging floor elevator of some sort is therefore always desirable. Yet I have seen dozens of plants in which the charging floor "elevator" consisted of an inclined plank and a wheelbarrow with a man to push it. Usually we also find in a plant of this sort that the storage bins (if there are any) for coke and iron are from 50 to 200 feet further removed from the charging floor than is necessary, and are laid out absolutely without regard to ease of access or economy in the handling of materials. In one particular case that came to the writer's attention, the

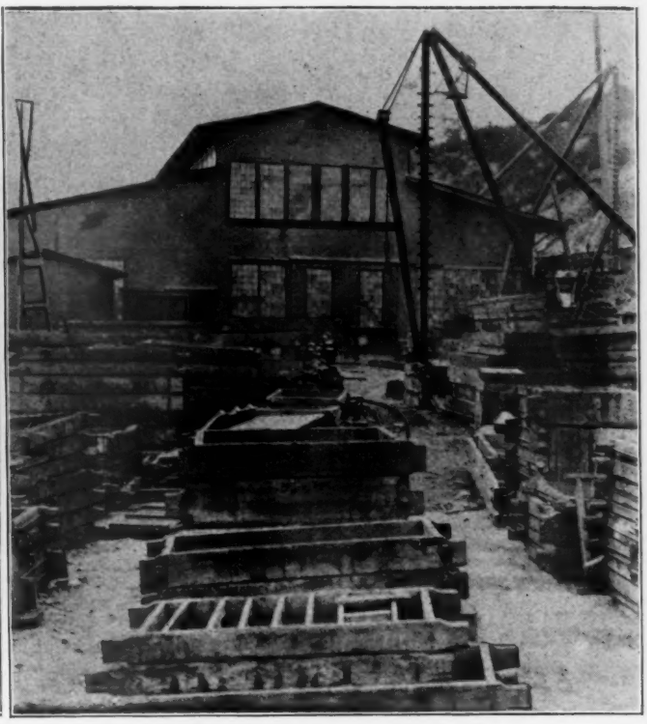


A Disgraceful Flask Yard—Note the Disorder, Neglect and General Slovenly Appearance

Flasks Neatly Piled, But in the Street



WHEELBARROW ROUTE TO THE CHARGING FLOOR—COKE BINS ARE LOCATED ABOUT 100 FEET FROM THE CUPOLA



A WELL ARRANGED FLASK YARD

coke and iron bins were located on the opposite side of the foundry from the charging floor, so that the man with the wheelbarrow had to walk around the end of the building, a distance of 190 feet, before he came to the charging floor incline. Every time the cupola was charged over two hours were wasted traversing this unnecessary 190 feet; the cost per year approximated $150. This $150 could have been saved at no expense whatever by properly placing the storage bins near the charging floor.

Enough money was wasted every year at this same plant by virtue of the wheelbarrow incline to the charging floor to have paid interest on a $3,000 elevator!

Badly Located Storage Bins.

It seems almost foolish to remark that the storage bins, particularly coke, should be located as to be reasonably free from depletion by thieves. Yet in a certain western city the writer saw three foundries, all within a radius of a few blocks, which, being somewhat crowded for space, actually stored coke, scrap iron and some heavy finished castings in the public streets and alleys. Several tenements were situated in the immediate vicinity and it goes without saying that the foundry coke piles were stolen from nightly in spite of the efforts of the night watchmen. In addition the several firms were liable to heavy fines for illegally obstructing public thoroughfares.

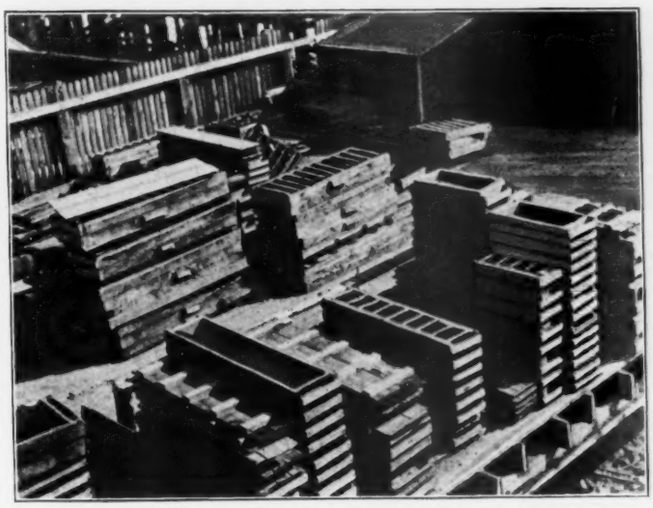
It is the continued existence of such leaks as these that drain the profits during a dull season.

Proper Location of Storage Bins.

The few examples given above are sufficient to show that the design of storage facilities and charging floor machinery is lamentably poor in many otherwise well laid out shops. Often the errors are such that notable savings may be effected at but little or no expense.

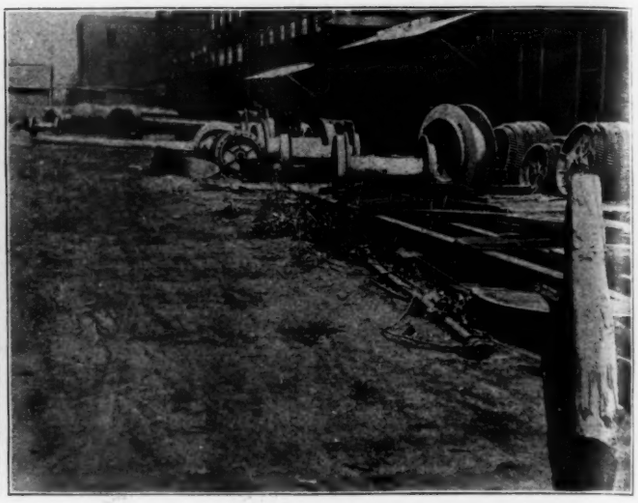
Wherever it is possible, arrangements should be made to store the coke and iron on the charging floor level so that no outlay of dollars will be required to lift these materials up to the charging doors. This is the ideal arrangement. If it cannot be obtained, then an adequate elevator with easily accessible bins on the ground floor is the only acceptable substitute.

I have already spoken of the economy that can be effected by providing simple transportation facilities between the foundry and the flask yard. Money can also be saved by paying some attention to the arrangement of the flask yard itself. Some yards look as if the foreman or superintendent had never paid them a visit. Now it does not cost any more to pile the flasks in a neat, orderly manner, grouping similar sized boxes together and placing the large, heavy ones nearest the foundry door so that they need be handled but short distances, than it does to dump them in a disgraceful pile as is fre-



FLASKS NEATLY ARRANGED ACCORDING TO SIZES

A Wheelbarrow Route to the Cupola



Scrap and Finished Product Stored in the Street

quently done. The saving, on the other hand, which results from an orderly arranged flask yard amounts to a good many dollars in a year. Furthermore there is the moral effect of orderly habits outside as well as inside the shop to be considered. Customers will not increase their orders when they see the miscellaneous stacks of old lumber that parade under the name of flasks in many shops; nor will the workmen be encouraged to give more careful and satisfactory service by the same sight. The flask yard is the eyesore of many foundries which are otherwise perfectly good; but from a purely economic standpoint, if from no other, there is no excuse for this condition.

Care of the Windows.

Simple negligence is often the cause of unnecessary expense. I visited a plant recently near the close of the day. The shop was provided with more than the usual number of windows and there was yet plenty of daylight outside. Nevertheless electric lights were being freely used inside. An examination of the window panes showed very plainly why the artificial light—costing 10 cents per kilowatt hour—was necessary. A thick, opaque coat of dust covered every window and fully 60 per cent of the light coming from the outside was absorbed in passing through the glass. A few minutes with a hose would have kept these windows clean and cut the electric light bill in two. The loss incurred by burning the extra light was, of course, not large, but its saving would have meant the stopping of one more of the little leaks that in the aggregate often produce failure.

Artificial Light.

On the other hand valuable time and first class workmanship are often sacrificed because a shortsighted management will not provide artificial light when it is necessary. Nearly all of us have seen molders waste time trying, with a couple of dingy mirrors, to reflect daylight around three corners and into the bottom of a deep mold. The attempt is seldom a success while an unskillful workman, blundering in the dark, often tears down one side of the mold as fast as he patches the other. A few portable electric lights will save all this difficulty and provide the molder with plenty of light where he needs it most. Yet comparatively few shops are provided with this time and temper saving convenience.

Cost System.

A cost system, simple and efficient, yet which tells with reasonable accuracy where the money is going is an indispensable aid to profit making in foundry operation. Numerous systems have been devised and tried with varying success. Herewith is the outline of one that is not generally used, but has been employed successfuly in certain western plants. By adding together the cost of materials, labor for preparing, daubing and charging the cupola, cost of power, cost of pouring and the incidental or overhead charges for any one heat and dividing the sum by the number of pounds of good castings produced at that heat we get what is known as the cost of melted iron in the mold. Now this factor multiplied by the weight of any particular casting gives the cost of melted iron for that casting. To this we add the cost of molding as determined from the molder's time slip and the sum is, with fair accuracy, the shop cost of the casting.

A practical cost system, careful attention to little details, rigid but not parsimonious economy, coupled with the "square deal" to every one alike will work wonders in keeping a shop running even when financial skies are lowering and customers are as scarce as leaves on the oak tree in midwinter.

OVERCOMING SPONGY CYLINDER FLANGES

BY H. E. KIMBALL

WE MAKE a good many cylinders weighing from 600 to 950 pounds, 12 inches in diameter, about 5 feet long and 1 inch thick, with a 4-inch flange at each end. We were troubled the same as our neighbors, but could not change the shape of the pattern, and changing shape would do no good. When the steam was turned on the leaks would show up in the neck of flange. I tried everything I could think of, such as different grades of iron, different grades of sand, different kinds of facings, also raising first one end of flask and then the other, but the spongy or dirty place in iron would show up at one place or another. We also used thousands of tons of scrap iron and when we would get castings in scrap of similar shape we would break them and find the same trouble there.

Now we are having no trouble from this difficulty, and I will briefly explain my method. I put 1¼-inch runner sprues on each side of the pattern about 6 inches from the end of flange, with a large runner basin at top. My gates were cut next to the core on each side and on top of the flange I put an overflow riser. I raised the end of the flask that I poured the metal into about 6 inches higher than the other end. Of course, the iron would flow to the bottom end first and then flow back as it filled up and brought all the fine particles of dirt and refuse iron back to the neck where the iron entered the mold. When it was full I had all the material that made the spongy place in the casting just beneath the overflow gate. I then continued to pour about 50 pounds of iron through the overflow gate and one could see the scum rise at the top and flow away on the body of overflow iron. One must let the iron at the overflow run off freely and not use it as a riser, for then the iron would not flow fast enough to carry off the refuse, but simply rise as the iron in the runner box filled the box. That is where the success lay in getting the iron out of the top of flange quickly. Instead of using facing I use Portland cement, shaking it on from a bag. It gets hard and gathers the moisture on the face of the mold and forms a skin dry surface.

ELEMENTARY NOTES ON IRON WITH A FEW SIDE LIGHTS ON MALLEABLE CASTINGS

BY C. A. SWALLOW

IRON is widely distributed in nature and its compounds are abundant. Probably no portion of the earth's crust is free from it, but it occurs native only in small quantities, and the iron thus found is probably of meteoric origin, and is always alloyed to a greater or less extent with other metals, as nickel, cobalt, copper, etc. The strong affinity of iron for the non-metals explains its infrequent occurrence in the native condition, and the dissimilarity between the metal and its ores may explain why iron was among the later useful metals to be discovered. It may be mentioned, however, that some writers think iron was known and used at a much earlier period in the world's history than is generally believed, but that the tendency of this metal to corrode has destroyed all traces of its use in ancient times, while instruments of brass and bronze remain.

Pig iron is usually classified as Bessemer, basic, mill, malleable, charcoal and foundry iron, depending on the purpose for which it is to be used, and the purpose for which it is to be used will govern its composition. Bessemer iron is for use in the manufacture of Bessemer steel and as practically all the phosphorus and sulphur in the iron remain in the steel, the percentage of these elements must be very low. By Bessemer iron is usually meant an iron containing less than 0.1 per cent phosphorus and less than 0.05 per cent sulphur. Mill iron is for use in the puddling mill, for the manufacture of wrought iron. It should contain a low percentage of silicon, and the iron made when the blast furnaces are working badly on foundry iron is sometimes used for this purpose. Malleable iron is used for making malleable castings. It usually contains more phosphorus than Bessemer iron and less than foundry iron, and the percentage of silicon and graphitic carbon is low.

Sampling for Analysis.

As pig or cast iron is the first product in the manufacture of castings, its analysis must be treated next. The principal determinations, and frequently the only determinations made are four in number, viz.: Silicon, sulphur, phosphorus and manganese. As all these elements tend to segregate to a greater or less extent, pig iron is never homogeneous. A single pig will not have exactly the same composition throughout, and, if samples are taken from different parts of a cast, the variation will be still greater. Hence the selection of a sample becomes a matter of importance if a cast is to be sampled. Probably the best method is to remove three samples of the molten iron as it runs from the furnace by means of a ladle, taking the first sample soon after the iron begins to run, the second when about half of it has passed out, and the third toward the end of the cast. After these test pieces have cooled they should be broken and an equal amount drilled from the center of each piece and the drillings mixed. A sample is thus obtained that, as a rule, quite closely represents the composition of the whole cast. If a car of metal is to be sampled, pigs should be taken from different parts of the car, and broken. The same quantity of drillings should be taken from the interior of each pig of iron and mixed. Iron drillings are always likely to contain sand and scale, and these must be removed before weighing up. This is best done by spreading the drillings on a clean paper, placing another paper over them and bringing a magnet in contact with the second paper. By lifting the magnet, which attracts the drillings and holds them close to the paper, part of the drillings are removed and then held over another clean paper. Then by holding the paper between the magnet and drillings firmly and withdrawing the magnet, the drillings are allowed to fall on the paper placed to receive them. By repeating this a few times, all the drillings will be removed to the second paper, while the sand and scale, being non-magnetic, will remain on the first. After mixing the sample thoroughly to get a uniform mixture of coarse and fine drillings, which usually differ somewhat in composition, the sample is ready to be weighed out for the chemical determinations.

Malleable Castings.

Whatever may be the scientific definition of a malleable casting, for commercial purposes it is one made of iron of special composition and rendered malleable by annealing. The composition of the hard casting lies between well defined limits, and it is affected by so many conditions that the successful production of this class of work is one of the most difficult branches of the iron industry. While the composition of a good malleable casting is but little different from that of a car wheel or a roll, yet it can be twisted, bent and

hammered out hot or cold, and has double the tensile strength of these products. This shows that the constituents of the castings are quite different. This difference may be due to the condition of the carbon in each. In the ordinary gray iron casting there may be three to four per cent graphite present. In the malleable casting the same amount is weighed as graphite in the analysis, but it has radically different characteristics. This form of carbon is due to the annealing process and might be called temper-carbon. One of the peculiarities of this form of carbon, is that if a malleable casting which on fracture shows a black velvet surface, is heated to a high temperature and plunged in water, all this amorphous carbon is dissolved and the fracture shows the grain of steel. The same is often seen when a casting is hammered cold, and more especially when a casting that has become warped is heated and straightened. The grain in the latter instances will not be as good as in the first one, but this shows that to straighten a malleable casting no heat should be applied, but pressure only. This characteristic of the carbon is often made use of to pass malleable castings for steel.

Of the properties of the malleable casting it may be said that the tensile strength should run between 40,000 and 50,000 pounds per square inch. Castings with only 35,000 pounds per square inch tensile strength are desirable for ordinary work. The writer has made castings running up to 54,000 pounds per square inch tensile strength, by using a large percentage of steel rail. This, however, is not recommended, as wherever such high results are required, they can best be obtained by the use of steel castings. The high resilience or resistance to shock in malleable iron is its most useful characteristic. It is well known in railroad circles that the ordinary steel casting is not nearly so good as a malleable casting for service, except where an exceedingly high tensile strength is required. It will be noted that owing to the removal of varying amounts of carbon from the skin to the center of the casting, no carbon determination of a malleable casting is of any value, unless the sample is taken before annealing, and even then it is only good for the total carbon. For an annealed piece a sample taken from the center of the casting with at least ¼-inch untouched around the drill would give a fair indication of the carbon contents, but even this method cannot claim accuracy.

In the former days of charcoal iron about 3¾ to 4 per cent carbon was the rule in malleable castings. At the present time of coke iron and steel additions to reduce the carbon, this may be run as low as 2.75 per cent before any trouble will be experienced in the annealing, or in the foundry through cracking and shrinkages. With the demand for a high tensile strength it is well to place the lowest limit of carbon at about 3 per cent and up, for common work the limit would be found in the saturation point of this grade of iron or 4.25 per cent carbon. It is absolutely necessary that the hard casting be free from graphite. Even a small amount of this indicates an open structure with the consequent ruin of the work in the annealing process due to the penetration of oxygen. The function of the silicon percentage arranged for in the mixture is to keep the carbon in the combined state. The rate of cooling depends on the cross section, the pouring, temperature of the metal, sand, etc. The sulphur is quite an important element in malleable castings and must by all means be kept down to a low percentage. The coke used is another important thing in malleable work, as iron readily absorbs the sulphur in the fuel which comes in contact with the iron while melting. Manganese is seldom troublesome as it does not often exceed 0.40 per cent in the heat, which means about 0.20 to 0.25 per cent in the casting. Above 0.40 per cent in the casting it begins to give trouble in the annealing and therefore manganese should be kept low. Phosphorus should not exceed 0.20 per cent, and is better kept below this.

Annealing Castings.

The writer has recently noticed that a certain malleable company is annealing castings in three days. Experiments on annealing in 72 hours gave much dissatisfaction, as the best grade of pig iron may be selected for the mixture in the melting furnace and be rendered useless in the annealing. The writer remembers visiting a foundry a few years ago where the superintendent had succeeded in convincing the company that he could anneal in three days. From the first oven dumped all the pots of iron and packing were hauled to the scrap pile. Some of the iron was hard, while the tops of the stands were melted. This company has now resorted to the reliable method of annealing.

In the annealing process we find two extremes leading to about the same results so far as the carbon change is concerned. A short anneal at a high heat is as effective as a long anneal at a much lower temperature. That is to say we can anneal or rather change the carbon in a casting by placing it over night in a melting furnace after cooling down, and we can do the same thing in an annealing oven at a much lower temperature, but giving it five days time in the oven. Of the two methods the latter is by far the best if the annealer wants to produce a high grade malleable casting, as it not only permits the change in the carbon, but also gives the carbon time to get out. Then again the chances of burning the castings in the anneal are obviated. The results are a good reliable casting, while in the hurry-up method it can never be told whether they are annealed at all. Sometimes they are, but often they are not.

After experimenting for generations on short annealing lines, people have come to recognize that the best and safest way is to arrange for an oven to be regularly recharged on the same day of the succeeding week. If the annealing ovens are properly constructed there will be no trouble in bringing them up to an annealing heat in 30 to 36 hours. When this high temperature is reached, a closing of the damper and maintaining the heat evenly for a period of, say, three full days at least, followed by a gradual cooling down to a black heat before dumping, gives the best results. Here is where so many mistakes are made in annealing, the pots being drawn red hot. If the pots are hot when the air touches them the delicate reaction of the carbon is disturbed, and an inferior material results. The writer always has had softer and stronger malleable iron from the anneal that had the extra day to cool down.

PIN HOLES IN CHILLED CASTINGS.

By Alex. E. Outerbridge Jr.

Pin holes occasionally appear in the white iron tread of chilled car wheels underneath the skin. This defect we traced to gas formed by a film of oil that was rubbed over the face of the iron chill to prevent its rusting, and the method we adopted was simply to rub the chills with a brush containing fine plumbago in its bristles. No oil was used. The graphite gave the chill a polished surface and the pin holes disappeared.

When high chilling iron contains over 0.08 per cent of sulphur, gas holes may be expected at almost any place in the casting. The best method of eliminating these holes is to add about one pound of ground, 80 per cent ferromanganese to 600 or 700 pounds of iron in the ladle just before pouring.

SYSTEM IN THE STOCK DEPARTMENT

Method for maintaining a stock record by card index---Issuing material on requisitions

BY J. CECIL NUCKOLS

WHAT is meant by stock? Under this term we must include all goods or stock to be resold in the form in which they are received, materials used in the manufacture of goods, the finished product and the necessary supplies used in the various departments. To properly organize a stock department we should divide the subject under several heads:

First—For the storing of stock a definite place should be provided.

Scond—A stock keeper should take charge of all stock as soon as it is received.

Third—A written requisition should be required for all stock issued by him, and this requisition should be signed by someone having authority to order stock for that particular department.

Fourth—An accurate record should be kept of all stock received, stock issued and the amount on hand.

Storing Stock.

The fact that a definite storage place should be provided for all stock on hand does not imply that all stock should be kept in the same place, but each separate class should have a definite place. A foundry has a fixed place for pig iron and for scrap; a woodworking plant has a place for each grade of lumber; well regulated factories always store small supplies in some particular place; and even the country store has a storeroom for goods not in use upon the shelves. Granted that we have provided proper places for storing stock, the arrangement of the stock itself should next be considered.

The arrangement of stock should be such that unnecessary handling is obviated. Stock most often required should be placed in the most accessible place, while that not called for frequently should be put in the most inaccessible corners. Where the concern is large enough to need several storage places, the stock should be arranged with special reference to the different departments in which it is used. Supplies that are used on the first floor of a factory should not be kept on the top floor. The main point to be considered is to place the stock where the least time will be consumed in getting at it, for in this, as in all other things in any factory, time is an important factor.

The Stock Keeper.

The responsibility of caring for the stock and keeping proper records should be placed on some one person. Thus we see the necessity of a stock keeper. It is not necessary to add another employe, though in large concerns such an addition will mean economy in the end. The main point is that some one person be held responsible for all stock and the recording of its distribution.

No prudent business man allows all his employes to have access to his cash drawer. So all of his employes should not be allowed to take stock from the stock room whenever they feel like it.

The first duty of the stock keeper is to receive the stock and attend to its proper storing and recording. A convenient form for recording stock received is shown in Fig. 1. Great care should be exercised in receiving stock. Possibly a contract has been made for goods which calls for certain quantities at stated periods. The first lot is found not to come up to specifications and the contract is cancelled. If the receiving clerk accepts another shipment of these goods the chances are that his concern will have to pay for them. Hence the necessity for the purchasing department giving the receiving clerk a written notice of orders which have been cancelled. In larger concerns a receiving clerk is necessary, but in the smaller ones the stock keeper himself can attend to this part.

The possibility of receiving goods which have not been ordered is done away with where the receiving clerk is given copies of all purchase orders. Careful attention must be given the receipt of goods returned by customers. To receive the goods places the shipper in a position where he must keep the goods and credit the customer's account; while to refuse them, places the

Receiving Slip

Date

Quantity	Articles	Received From	Condition

The Foundry

FIG. 1—STOCK RECEIVING CARD

Article			Size or Kind		Unit	Where Stored		High	Normal	Low
Date	Rec'd	Ord. No.	Deliv'd	On Hand	Date	Rec'd	Ord. No.	Deliv'd	On Hand	

The Foundry

FIG. 2—STOCK CARD SHOWING QUANTITIES ONLY

burden on the customer to show good cause for their return.

As a rule stock records may be divided into two classes; those showing quantities only, and those showing values as well. Both cards and loose leaf books may be used. Personally the writer prefers loose leaves for many reasons. Fig. 2 shows a simple form for the first class, and is especially adaptable to jobbing and manufacturing concerns. For each article in stock there should be established a high and a low limit, so that the stock keeper may notice when making his entries whether a certain stock is low or high. Adjustable tabs may be used to automatically indicate when any stock is running low. The position of these markers (at high, normal or low) will always show of what goods there is too large a quantity and what should be bought.

Requisitions.

No stock should be issued without a signed requisition. These are necessary so a record may be had of what has been delivered, when, to whom, and for what purpose. All requisitions should be signed by a department head or some one to whom he has given authority. Fig. 3 shows a convenient requisition form. When filing requisitions it will be found best to file by departments, designating the departments by letters, as A, B, C, etc. Then number the requisitions 1-A, 2-A, etc. In this way a record of requisitions by departments can easily be furnished.

Checking the Stock Records.

Without some sort of a check it would be unreasonable to expect an absolutely accurate stock record. The method adopted in the best organized stock departments is to call for a count, at irregular intervals, of some one item. In a manufacturing concern a count of the bolts may be called for one day, on another it will be screws, etc. The stock keeper knows he may be called upon any day to furnish a count of any given item, but just when, he does not know. The result is that he is likely to be very careful in making his records, as he will not knowingly place himself in the position of showing a discrepancy.

The principles of stock keeping are the same, no matter what the size of the concern. In some concerns the keeping of stock may require the services of a stock keeper and several assistants, while in others it may only require part of the time of one of the employes. Fig. 4 shows a chart of the general divisions of the duties of the stock keeper and the records that he should keep.

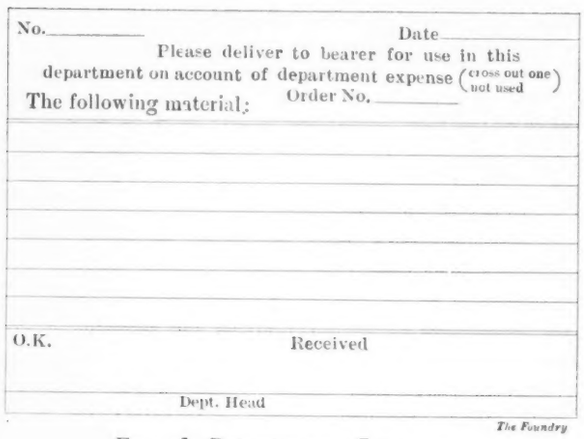

No._____ Date_____
Please deliver to bearer for use in this department on account of department expense (cross out one / not used)
The following material: Order No._____
O.K.
Received
Dept. Head
The Foundry

FIG. 3—REQUISITION CARD

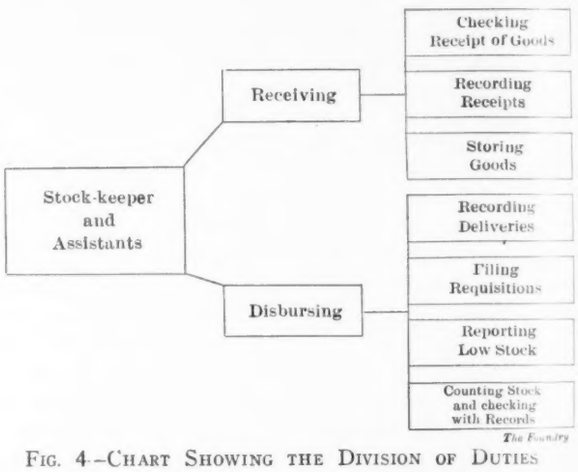


FIG. 4—CHART SHOWING THE DIVISION OF DUTIES OF THE STOCK KEEPER AND ASSISTANTS

BLOW HOLE DIFFICULTIES.

BY W. J. KEEP

Question:—We are engaged in jobbing foundry work and have experienced a great deal of difficulty with blow holes in both heavy and light castings. We are obliged to feed every casting that has a hub or a boss and blow holes are a frequent occurrence. Our charge consists of 1,300 pounds of pig iron, 200 pounds of steel forgings and 500 pounds of our own sprues. We have been using from 8 to 10 pounds of ferro-manganese for each ton of iron.

Answer:—There may be a possibility that your coke is somewhat higher in sulphur than formerly. Use 40 per cent of limestone to the ton of iron and melt hot to eliminate the sulphur. You should use about one-half ounce of pure aluminum for every 100 pounds of iron melted, owing to the fact that you are using 200 pounds of steel in your mixture. The aluminum should be put into the ladle and the iron poured on the same.

SPONGY AUTOMOBILE CYLINDERS.

BY W. J. KEEP

Question:—We are having trouble with automobile cylinders which are evidently spongy and do not withstand the hydraulic test to which they are subjected. We are using an English brand of pig iron, which analyzes as follows: Silicon, 3.33 per cent; phosphorus, 1.51 per cent; sulphur, 0.05 per cent; manganese, 0.70 per cent; combined carbon, 0.10 per cent; graphitic carbon, 3.37 per cent. We use 40 per cent of the above and 60 per cent of good machinery scrap. The cylinders are cast on end, head down, and are gated in the bottom. We use a very hot iron. The cylinders show porous and spongy spots around the head. It appears to us that the light parts are drawing away from the heavier sections. We also have trouble with the chilling of the lighter sections. Another mixture which we have used contains 45 per cent of English pig iron and 55 per cent of car wheel scrap. We use only the centers of the wheel and found that the castings made from this mixture did not leak in the heads but nevertheless are porous and spongy about half the length of the cylinder.

Answer:—The lower the percentage of silicon the less danger there is of sponginess, but a chilling iron should not be used, especially since the thinner parts of the cylinder had chilled spots when the regular mixture was used with no steel scrap. The iron should be poured as cold as possible and chills should be used on the heavier parts of the castings to bring about uniform cooling.

PRODUCTION OF MALLEABLE CASTINGS--IX

An exhaustive discussion of the construction and operation of the open-hearth furnace for melting iron for malleable work

BY RICHARD MOLDENKE

CONSIDERING finally the open-hearth furnace for malleable practice, we find the advantages as follows: Short heats, very hot iron, high efficiency, makes castings of the best quality, and has ideal melting conditions.

The disadvantages are: High first cost, great skill required to operate properly, must be kept in operation continuously, frequent and heavy repairs, requires gas instead of coal direct. As an additional advantage it may be said that with an acid open-hearth furnace, alternate heats of malleable cast iron and acid steel can be made, if desired, and at least one plant is doing so today in this country.

An open-hearth installation represents the highest type for melting so far devised, not even excepting the electric furnaces. Gas, the ideal fuel, must be used. If of the natural and rich variety, matters are simplified very much; if this is not available, a gas producer plant must be added to the installation. On the other hand, fuel oil can also be adapted for this furnace, and is fed either with super-heated steam, blown in with compressed air, air at low pressures by fan, or simply dropped on a tile on the hearth. The oil is instantly gasified and the regular process obtains.

Construction of the Open Hearth.

Essentially, the open-hearth furnace consists of a steel basin in which there is put a heavy lining of fire brick, and this is coated with successive layers of fire sand burned on, one after the other. This basin is arranged to be tapped from without to draw off the molten metal. Below this steel basin or hearth are four large chambers filled with checker brick, the function of which will be explained later. Over the basin or hearth comes the crown, and at the two ends the port arrangement for the gas and air. The whole is well tied up with beams and rods, is provided with charging door and gas and air valves, a charging platform and stack. A 20-ton furnace may mean the expenditure of some $10,000.

The open-hearth furnace is designed to utilize all the heat possible from the combustion of the gases with the air supplied. Reference to a section of such a furnace will show that the gas, on passing through the gas valve, as well as the cold air passing through the air valve, each first go through their flues into the respective chambers filled with checker brick—let us say on the left hand side of the furnace. They come up and pass through the ports, the gas catching fire as it enters the combustion space over the hearth. In burning, the furnace is heated up. The products of combustion now pass into the opposite ports—those on the right—pass down the flues into both the gas and air chambers filled with checker brick, heat up this brick, and having given up considerable heat, they pass out through the lower flues, through the gas and the air valves and out of the stack.

Heating the Furnace.

This process is continued for about 20 minutes in the ordinary furnace, and then the valves are reversed. The gas and air now come through their respective valves, which by the reversal have cut off the connection of the flues with the stack on that side, and passing through the heated flues go into the hot chambers, become highly heated, then passing through the ports into the melting space, the gas burns and the products of combustion come out through the checker chambers on the other side and out of the stack again. In this way alternately on one side and then the other the ports, chambers, and flues of the furnace become highly heated from the passing products of combustion, while on reversal this heat is given up to the air and gas allowed to enter cold. The result is that gas and air arrive at the point

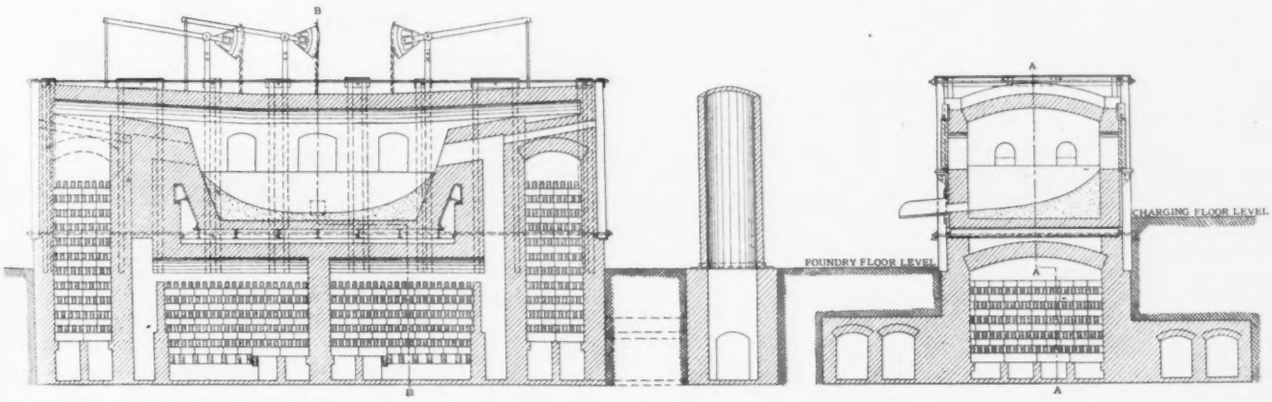


FIG. 1—OPEN-HEARTH FURNACE FOR MELTING MALLEABLE IRON

of combustion very hot, and the temperature of the furnace is very much higher than it would have been had the heat thus utilized not been saved. In fact, unless this arrangement is used, it is impossible to get enough heat to melt the metal.

It will be readily seen that with cold air and gas passing through chambers full of checker brick, say at 1,000 or more degrees, it will not be long before the temperature of these brick will be sensibly reduced, and by the time they have dropped to 500 or 600 degrees, it will no longer be economical to work that way. On the other hand, as the hot products of combustion pass through the checker chambers on the other side, the brick there are raised from the 500 or 600 degrees they were at the time of reversal to nearly the temperature of the gases passing out. Keeping this up any longer would be wasteful, for no further heat would be given up, while at the same time on the other side there would be little heat for the air and gas to take up. Hence, experience has shown that a certain number of minutes between reversals of the system give the best economical results. Attention to the temperature of the stack is the best criterion of what is going on within the furnace. It takes 500 or 600 degrees Fahr. stack temperature to give enough draft for operating the furnace. This is the minimum, and will be found there a few minutes after the valves have been reversed, the products of combustion passing through checker chambers thoroughly cooled by the cold air and gas. On the other hand, from that time on the temperature of the stack will gradually rise, the checker brick getting hotter, and hence let more heat pass out with the escaping products of combustion. When a point is reached where the stack temperature is nearly 1,000 degrees Fahr. or better, not over 900 degrees Fahr., it is time to reverse, otherwise loss in fuel results.

As a result of this practice a fuel efficiency of one pound of coal to six of iron melted is attained. This is still higher than cupola practice for ordinary gray iron castings, but there is a big difference in the quality of the work made.

The air allowed to be drawn into the furnace, for everything depends upon the stack draft, must enter cold. This is necessary for the reason that hot air contains too little oxygen for a given cubic content to properly support combustion. Very frequently, with open-hearth furnaces not giving good results in a hot shop, changing the point from which the air is drawn into the air valve of the furnace makes a big improvement.

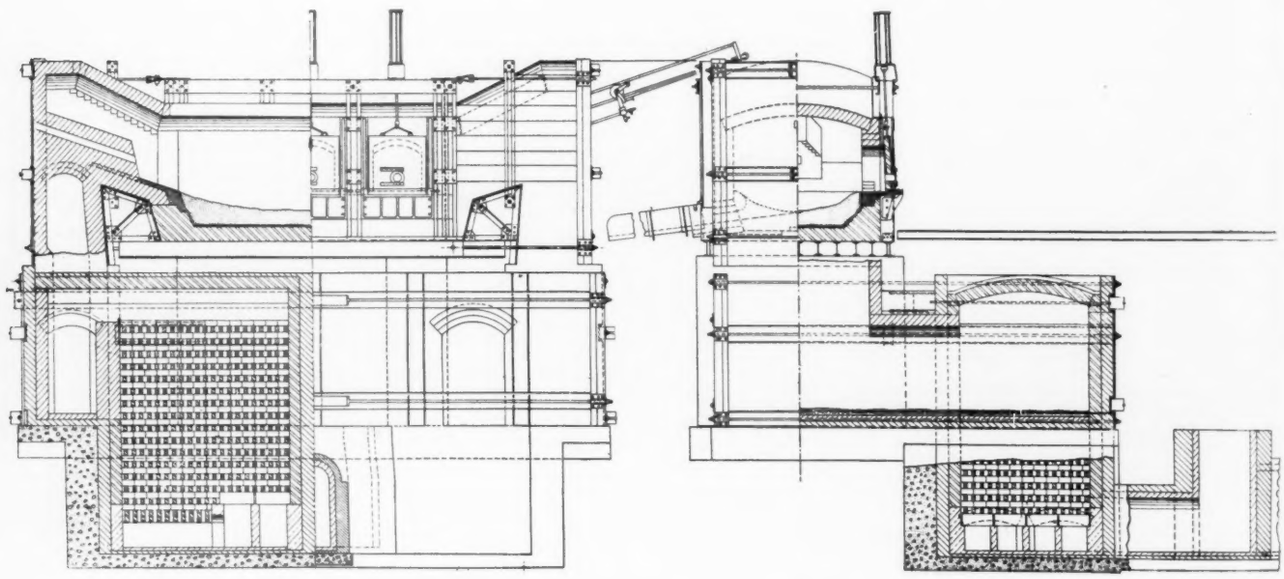


FIG. 2—OPEN-HEARTH FURNACE, 10 TONS CAPACITY, FOR MELTING MALLEABLE IRON

Fuel.

In open-hearth practice in this country we have to deal with natural gas, producer gas from bituminous coal, and oil gas from fuel oil. In the case of natural gas, with its very high heating value, it is not necessary to regenerate it for ordinary melting. So in this case the two checker chambers on each side of the furnace are used for the regeneration of the air, the natural gas being introduced through several 2-inch pipes through the ports on each side. The two valves controlling the gas are brought to one end of the furnace, so that the melter can turn one off and the other on without trouble, when reversing his air valve, no large gas valve similar to the air valve being required in this case at the stack entrance. While it is not necessary to regenerate natural gas for malleable work, it can of course be done, and the author remembers doing so for some time, and getting 10-ton heats in as low as one hour and 58 minutes from the end of charging to tapping. The furnaces, however, got so hot that they practically ran away, and the iron, though intensely hot, suffered considerably. Hence return to regeneration of air only was necessary. As a little point to be observed it may be stated that where natural gas is regenerated, the pipes close to the furnace, or the gas box, if this is introduced between pipes and gas valve, and in fact the large gas valve itself (for with regeneration of gas this is required) get so hot that carbon is deposited within them, and trouble soon ensues. To obviate this, a ¼-inch steam pipe is attached, and a little steam is allowed to pass in with the gas, this effectually preventing this carbon deposition.

Use of Natural Gas.

Natural gas for the open-hearth furnace not only gives magnificent results, but is very easy to handle. Enough should be used to just show a little smoke at the top of the stack after reversing, and also puff

out of the cracks of the furnace doors occasionally, showing that a reducing flame is within. Too clear a flame, that is a sufficiency of oxygen, may tend to burn the iron, and while this may be quite economical so far as gas consumption is concerned, the loss of castings and metal burned is greater than it should be. The gas should not come in at over five ounces pressure. Preferably it should be regulated for constant pressure, and come through large pipes. It should roll over the hearth lazily, and enter fairly low, the air coming in above it. This gives the best results for melting. With everything going right, in malleable practice, a 10-ton heat should not take more than 2½ hours between the end of charging and tapping. A 20-ton heat will take four hours. Where this time is exceeded it will be well to look into how the furnace is handled, or the charge is figured up.

An open-hearth furnace built by Wm. Swindell & Bros., Pittsburg, is shown in Fig. 1. It differs only from the accepted type of furnace in having one checker chamber on each side placed at the side instead of under the hearth. The opening for the introduction of natural gas, or oil for that matter, is shown plainly on the right hand side of the longitudinal section. Both chambers on each side of the furnace are in this case intended for the regeneration of air only.

Use of Fuel Oil.

Where oil is to be used for fuel, all the checker space is also used for the regeneration of the air only, as the gas made from oil is very high in heating value. A 10-ton furnace of this kind, designed by W. M. Carr, New York City, is shown in Fig. 2. Here the checker chambers are very large and are placed below the hearth in the usual way. The oil is made to come in at the end as shown.

The author has always preferred to have oil come into his furnaces, when he used this fuel, from the side, the pipes being placed at an angle and downward, so that the flame came from the side, front and back, and pointed toward the middle of the hearth. Reversal of the air valve meant the shutting off of the oil from one side and turning on of the other. Hence there were four pipes in this arrangement, two on each side, each provided with a small steam jet, to allow a little steam to pass through the pipes into the furnace when the oil was turned off. This prevented the burning off of the pipes when the heat struck them. Whether superheated steam, compressed air or wind from a fan, each coming through properly proportioned pipes, was used, or whether the oil was allowed to drop from the crown of the furnace on a tile at the end of the hearth, the result was an efficient flame which did the melting excellently. It must be said, however, that no fuel is as hard on a furnace as oil, especially, if for any reason the oil found its way back into the ports and down into the slag pockets. This was usually disastrous. A roaring furnace resulted which melted brick, iron and everything else indiscriminately. This was usually not noticed until that portion of the crown dropped in, and then repairs were in order. Fortunately for open-hearth furnaces, the price of fuel oil is kept at a point which usually makes its use prohibitive for large installations.

The experience of the author with the various methods of using oil for melting have developed the following as the best system. The oil taken from the cars, passes into an underground tank, provided with a steam coil to keep the sludge that will be found in the oil liquid in winter weather. A pumping system is installed which by a suitable regulator keeps the oil at a pressure of 40 pounds, and distributes it to every part of the works where it may be used. Just before it passes into the furnace the pipe is enlarged to allow the introduction of a strainer, which prevents sand or scale from the pipe from getting into the valve and causing trouble. This oil pipe, again reduced, passes through a larger air pipe into which a fan blows air at about three ounces pressure. This air can be shut off by a gate. The air blows the oil into the furnace, where it is entirely consumed, no gas carbon is formed, and the evils of local combustion are minimized as much as possible.

Fig. 3 shows a 20-ton open-hearth furnace built by S. R. Smythe Co., Pittsburg, for the Pennsylvania Malleable Co., McKees Rocks, Pa., in which the author was interested at the time. It also shows the three-spout arrangement which proved so successful in use. The first heat is being taken off at the time the picture was taken, in 1900, and was carried away in six-ton ladles for distribution in the plant. Natural gas was used for melting, as it was plentiful at the time, and excellent results obtained.

FIG. 3—OPEN-HEARTH FURNACE, 20 TONS CAPACITY, PROVIDED WITH THREE POURING SPOUTS

Producer gas is used for fuel in the open-hearth furnace, and as this will be the only fuel for the times to come, it is well to look into this question more closely. This gas must be regenerated as well as the air, otherwise trouble is certain to follow. Those who have been induced to try the other arrangement know this to their cost.

THE FOUNDRY

PUBLISHED MONTHLY BY
THE PENTON PUBLISHING CO.

BOSTON.....73-74 Journal Bldg.
BUFFALO.....932 Ellicott Sq.
CHICAGO.....1328 Monadnock Blk.
CINCINNATI.....First National Bank Bldg.
NEW YORK.....90 West St.
PITTSBURG.....510 Park Bldg.
SEATTLE.....302 Pioneer Bldg.

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The subscription price of THE FOUNDRY is $1.00 a year in the United States and Mexico. To Canada, $1.50. To Great Britain, Eight Shillings. Single copies, 15 cents each.

Change of advertising copy must reach this office on the 10th of the month preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Practical articles pertaining to the trade in all its branches are solicited, and will be paid for.

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Entered as second-class matter at the Post-Office at Cleveland, Ohio.

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Foundry and Manufacturers' Supply Association

By a recent vote of the members of the Foundry Supply Association it was agreed by a large majority to change the name of this organization to the Foundry and Manufacturers' Supply Association, the sole object of this move being to increase the interest in the annual meetings by permitting machine tools and other equipment to be exhibited in connection with foundry supplies, in which foundrymen generally are interested. This action has not been prompted by a desire to hold an independent exhibit apart from the annual meeting of the American Foundrymen's Association, but on the contrary, this society will affiliate with the other foundry organizations as heretofore. It is believed that by enlarging the scope of the association, the membership can not only be materially increased, but the exhibits can be made more interesting to those affiliated with the foundry industry.

Development of the Foundry Industry

While the foundry industry has apparently shown little or no growth during the last 12 months, radical changes in processes have been made which will not be appreciated to their fullest extent, until we are again on the threshold of another era of prosperity. Seemingly dormant, as a result of the restricted demand, the foundry trade will awaken from its lethargy well prepared to cope with the country's increasing casting requirements. Foundrymen have not been idle notwithstanding the dearth of orders, but have taken advantage of the lull by improving their methods and have reduced operating costs by the installation of labor saving machinery. Throughout the growth and development of any industry we are prone to overlook the important factor that has made the forward movement possible. It is doubtful whether the maker of foundry equipment is given full measure of credit as a contributory element that has made possible the unusual expansion of this trade. Yet, to his ingenuity and resourcefulness must be accredited much of recent progress. To his inventive genius, the perfection of the molding machine is due, as well as other appliances which are now considered indispensable in every foundry, and which were at first accepted with considerable trepidation. Unfortunately, first cost is frequently the deciding factor in favor or against the installation of a new tool, and purchasers of molding machines have, at times, reduced the price of this equipment to the cost per pound of the castings from which they are constructed. The financial investment involved in years of experimental work is frequently not given serious consideration by the prospective buyer, who only too frequently estimates the value of the machine by the pounds of iron it contains. Yet, through persistent effort, these foundry specialty manufacturers have built up an extensive industry whose prosperity is reflected in the forward march of the foundry trade. All tools and appliances, as well as supplies, required in a casting plant are now made by specialists in their respective lines, and the founder who builds his tumbling mill, erects his crane, or casts his pattern letters which can be purchased for a trifling sum, is not in sympathy with the spirit of the times, nor is he effecting an actual saving by doing so, provided he carefully considers the cost of his patterns, rigs, etc., and the time expended on work for which he is not economically equipped.

Trade Outlook

All branches of the foundry industry report a slight improvement, and indications point to a heavier demand after the presidential contest has been decided. In the malleable industry occasional low prices are disturbing factors and a few gray iron foundries are naming prices that are below cost, notwithstanding the ruling quotations for pig iron. Steel casting plants are still suffering from railroad retrenchments. Pig iron remains practically stationary in price and producers name the following quotations in the leading centers: No. 2 standard, Philadelphia, $16.75; No. 2 local, Chicago, $16.50; No. 2 Birmingham, $12.75 to $13; No. 2 Cleveland, $15.25 to $15.50; Lake Superior charcoal, Chicago, $19.50. The only large purchase of pig iron recorded during October involves about 350,000 tons of basic sold to an independent Pittsburg steel interest for delivery at a rate of 6,000 tons per month, over a period of five years. The contract is on a sliding scale, based on the cost to the furnace.

FOUNDRY & PATTERN SHOP EQUIPMENT

Bench Molding Machines --- Sand Blast --- Enameling Oven --- Large Cupolas --- Tilting Crucible Furnace --- Plunger Core Machine --- Walking Jib Crane --- Rockover Molding Machine --- Core Box --- Pressure Blower

THE accompanying illustrations show a new bench molding machine developed by the E. H. Mumford Co., Philadelphia. This machine is so constructed that sand falling under the table cannot come in contact with the working parts, and the operator is enabled to keep the sand from under the machine just as on an ordinary bracket bench. The machine is of the squeezer type, the table being operated by a 10-inch cylinder placed below it, whose stroke is limited to 4 inches. The cylindrical case A, Fig. 2, shown under the table, contains a guide and stop rod forming a part of the ramming plunger, and in addition to guiding the plunger prevents any possibility of blowing the table and plunger out of the cylinder. This construction eliminates the necessity of having a safety locking device on the main throttle valve.

The air supply to the cylinder is controlled by the standard motorman's brake valve manufactured by the National Brake & Electric Co., and commonly used on electric cars. The Mumford company adopted this valve for its regular line of power ramming machines three years ago. It is practically dust proof, and the bonnet forms a grease cup which is readily removable for cleaning the valve and charging the grease, without disturbing any of the pipe connections. The throttle valve, counterbalance spring, blow valve, vibrator and hose are attached to the elevated base of the machine.

The mold is rammed against a presser board carried by the yoke B, Fig. 1, the presser board being adjustable by means of a screw passing through the yoke. This yoke is made of cast steel, enabling a light but stiff construction to be used. In the operating position it is fastened over the table by means of a T-shaped locking hook, which engages in a slotted lug C at the front of the machine. The slotted lug in addition to engaging the T-hook acts as a rest for the drag flask and follow board, while they are being turned over on the table of the machine. After the mold is made and the T-shaped locking bar disengaged from the slotted lug, the counterbalance spring shown at the rear of the machine carries the yoke to the upright position as shown in Fig. 2. This action is automatic, the operator only being required to remove the locking hook from the lug.

The ramming block is carried by a square threaded cast steel screw and can be readily adjusted to suit varying depths of flasks by turning the wooden block of the yoke mechanism, after knocking out of its seat the upright pin D, which is shown back of the screw. The table of the machine is 12 x 16 inches and the space between the underside of the ramming block and the table available for ramming varies from 8 to 16 inches. The machine may be adjusted to varying heights to suit the operator by means of the rack and pinion shown on the back legs of the machine in Fig. 1. If desired, however, the machine is made without the adjustable legs.

The machine complete, including adjustable legs, as shown in the illustrations, weighs 675 pounds.

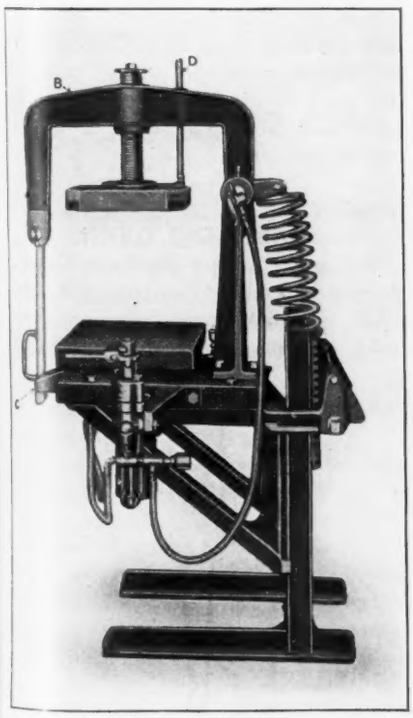


FIG. 1—BENCH MOLDING MACHINE OF THE SQUEEZER TYPE

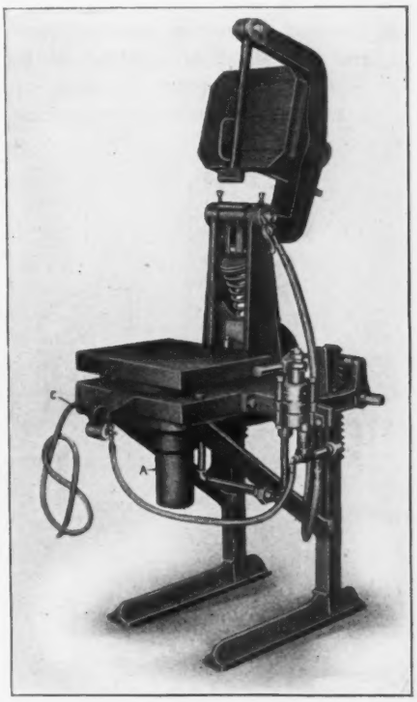


FIG. 2—YOKE OF BENCH MOLDING MACHINE IN UPRIGHT POSITION

SILICON ALLOY IN THE FOUNDRY.

The United States and Canadian patents taken out by Alexander E. Outerbridge Jr., covering the use of silicon alloy in the ladle, have been acquired by the Metallic Alloys Co., 32 Cortlandt street, New York City, which now has the exclusive right to license the operation of this process for softening, strengthening and cleaning cast iron in the countries named. Full details of this remarkable discovery have been given in various issues of THE FOUNDRY, notably in articles published in July, 1906, and January, 1907. The method of operation with this process is extremely simple, consisting merely in dropping a quantity of the alloy on the bottom of the ladle just before tapping. The quantity used depends entirely upon the kind of iron employed and the kind

of castings desired. The alloy becomes immediately diffused throughout the molten metal in the ladle, with the result that the strength, ductility and machining speed of the castings are increased, there is less likelihood of castings cracking, shrinkage is reduced, the iron is cleaned and blow holes are much less frequent and other important benefits are secured. Lower grades of pig iron and larger quantities of scrap can be employed. As it manufactures a complete line of alloys, the Metallic Alloys Co. is in position to furnish this silicon alloy properly prepared for all classes of foundry work.

FIG. 1—FRONT OF JORN SAND BLAST APPARATUS

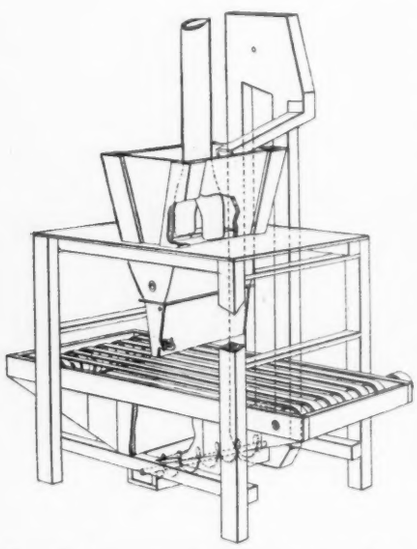


FIG. 2—INTERIOR CONSTRUCTION OF JORN SAND BLAST APPARATUS

JORN SAND BLAST APPARATUS.

A new sand blast apparatus invented and manufactured by A. Jorn Jr., Waukegan, Ill., is illustrated by the accompanying views and drawing. Figs. 1 and 2 are front and rear elevations and Fig. 2 shows the interior arrangement of the apparatus. The apparatus is unique in its manner of feeding the sand into the air blast and of recovering the sand for continuous use until it is reduced to dust and is carried out through an exhaust pipe. In addition, unusual advantages are claimed in the matter of simplicity, cheapness, efficiency and effective area and the standard 18-inch sand blasting apparatus is calculated to sandblast an area of 150 to 180 square feet per hour.

The apparatus shown in Fig. 2 and the elevator for raising and returning the sand to the blast after each successive using is entirely enclosed in a frame structure. The sand for the blast is discharged from the elevator through a spout into a supply hopper where it accumulates around the twin outlet Y-end of the blast pipe. The hopper is fitted over a nozzle bottom, a cross section of which is shown in Fig. 4. This nozzle is separated from the hopper by a partition which has in it a central opening admitting the sand to a central compartment and also two openings for the admission of the air pipes on either side into the air chamber of the nozzle, the air chamber jacketing the sand compartment on both sides. Both compartments have a lateral convergence toward the discharge opening of the nozzle. The admission of the sand into the air blast is controlled by a cylinder mounted on a shaft so placed in the mouth of the sand chamber that the cylinder controls the aperture. The cylinder is made with longitudinal grooves, the entire circumference being so provided. The sand descends from the hopper above upon this cylinder, directed and retained by proper deflectors and lips, and fills in the grooves on the exposed surface of the cylinder. The cylinder then revolving acts as a valve and the grooves act as valve ports with the result that a regular and uniform discharge of the sand into the air blast is accomplished. The rapidity of the discharge can be controlled by the speed of the rotating cylinder. The discharge nozzle may be adjusted for varying areas to be sandblasted by swinging out one side of the nozzle on its hinges.

The support for the work to be sandblasted consists of a set of parallel endless belts hung on rollers as shown in the illustration. The sand falls between these belts into a helical screw conveyor which transfers the sand to the boot of the elevator mentioned above, whence it is returned for further use.

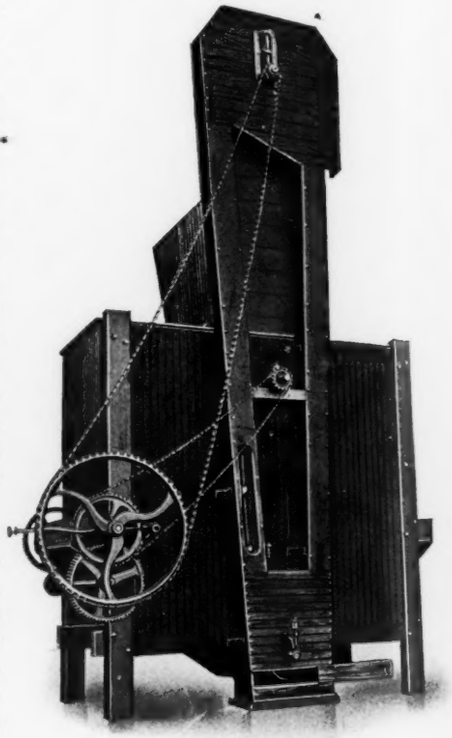


FIG. 3—REAR VIEW OF JORN SAND BLAST APPARATUS

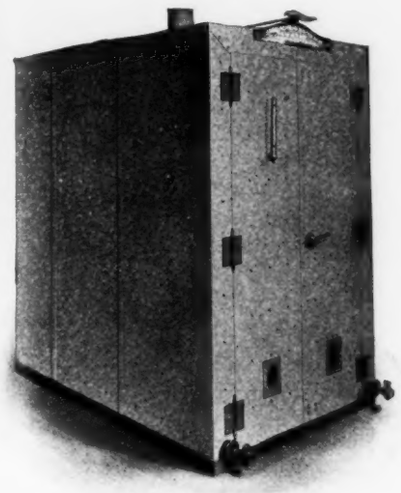
A SECTIONAL JAPANNING AND ENAMELING OVEN.

The accompanying illustration makes clear the method of construction of a novel japanning and enameling oven which is being placed before the found-

FIG. 4—NOZZLE OF JORN SAND BLAST APPARATUS

ry trade by the Fred K. Wells Co., 18 Warren street, New York City. This oven is built in sections, which are held together by a patented binding slide, allowing for expansion, eliminating the use of bolts and rendering impossible the warping of the sides. The material and workmanship of this oven is such that it is practically indestructible. The base is of soft steel, but for the top and sides galvanized iron is employed. The lining is of asbestos molded blocks securely bolted in place. Double doors are provided, these being fitted with a triple locking device, and the oven is equipped with hooks for adjusting racks or shelves and with a thermometer registering up to 500 degrees Fahr.

The sectional or knock-down method of construction renders the oven portable and easily handled, as it can be shipped at small cost and readily assem-



SECTIONAL JAPANNING AND ENAMELING OVEN

bled without the aid of skilled mechanics. The size illustrated, 4 feet wide, 6 feet deep and 6 feet, 6 inches high, inside dimensions, is but 20 inches high when knocked down for shipment and can easily be taken through an ordinary door or window opening. The weight is about 1,400 pounds, the heaviest section being the base.

In order to secure perfect regulation of temperature and thoroughly uniform results, gas is employed in heating this furnace, although steam can be provided for, if desired. Bunsen atmospheric burners are used, being economical, requiring no power for their operation and adapting themselves to any size oven. These burners are made of 1 to 2-inch pipe with holes drilled the entire length. The economy, reliability, convenience and cleanliness secured through the use of gas as fuel for other industrial purposes hold good also in connection with japanning. Where power is available and pressure burners are desired, they can be employed without difficulty.

This oven is built in a number of standard sizes or can be constructed to special specifications. The Fred K. Wells Co. is also seller of gas appliances for general industrial purposes, such as gas forges, melting pots, etc.

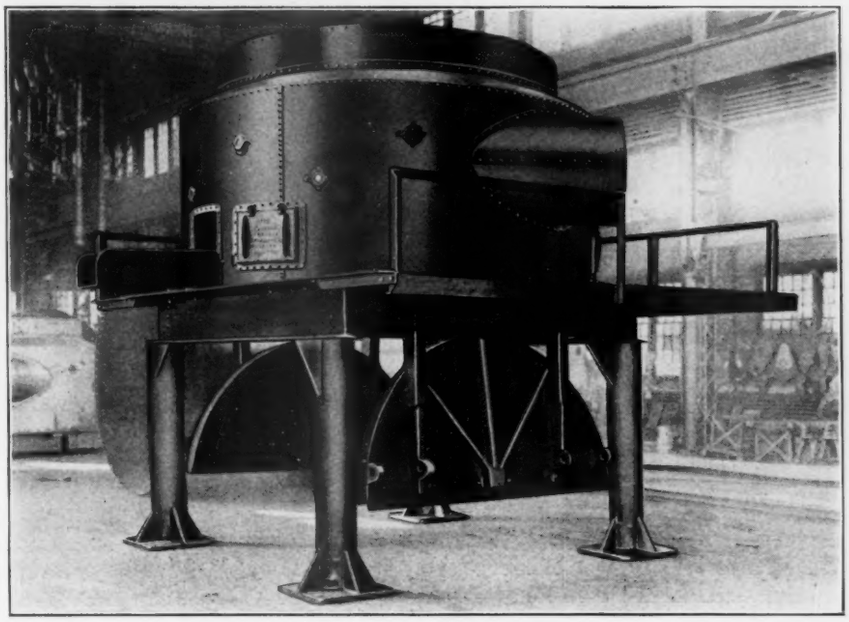


FIG. 1—LARGE WHITING CUPOLA SHOWING TAPPING SPOUT AND BLAST PIPE INLET

TWO LARGE CUPOLAS.

In Figs. 1 and 2 are shown two No. 12 cupolas built for the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa., by the Whiting Foundry Equipment Co., Harvey, Ill. While in general design these cupolas are similar to the standard Whiting cupola, several new features have been embodied. The shell is 108 inches in diameter and the windbox 132 inches in diameter with a 10½ inch lining. Each cupola has a capacity of 27 to 30 tons per hour, and is fitted with two rows of tuyeres, eight in each row. The bottom plates of these cupolas present some new features in furnace construction. On account of the extreme loads carried, the bottom plate and framing are made entirely of struc-

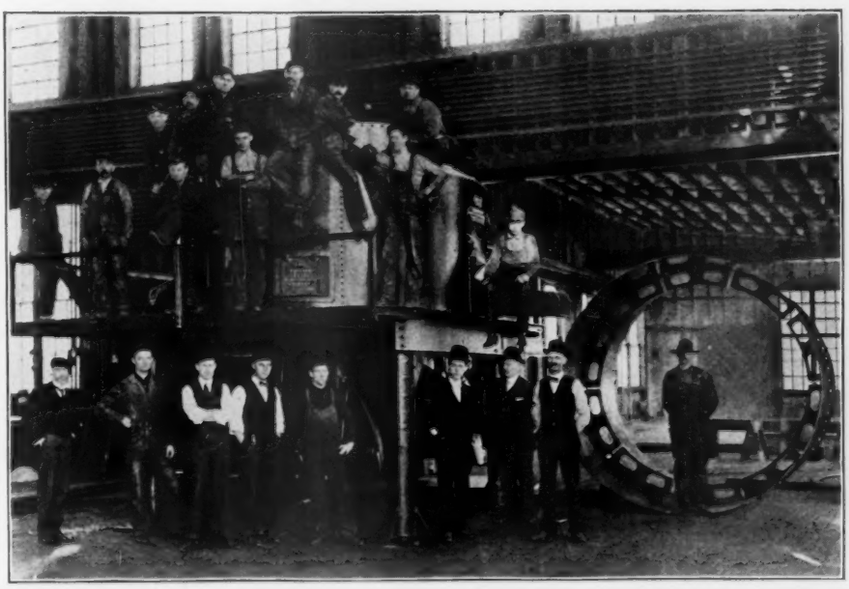


FIG. 2—EMPLOYES GROUPED ON WHITING CUPOLA TO SHOW ITS EXTRAORDINARY SIZE

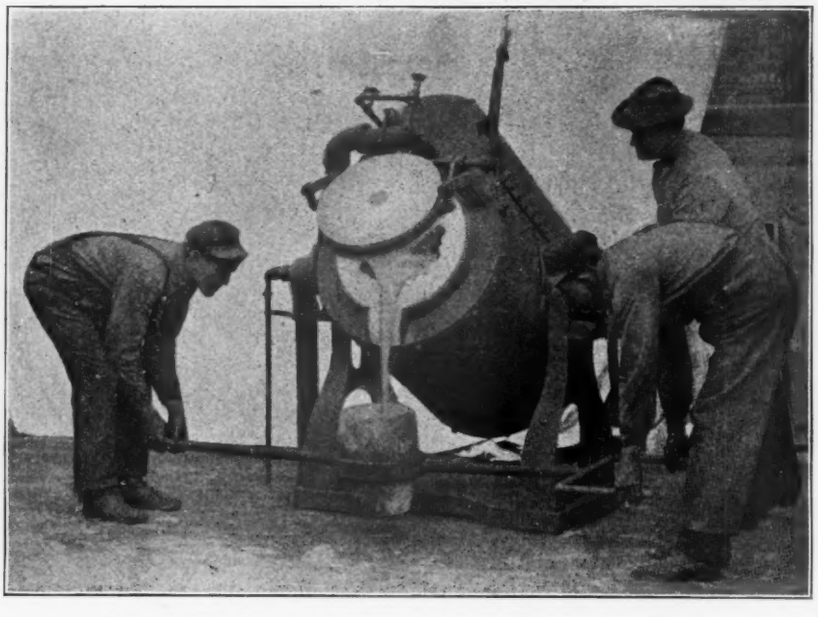


FIG. 1—ROCKWELL MELTING FURNACE TILTED FOR POURING

tural steel and consists of a heavy steel plate securely riveted to the shell and wind box sheets, and is bolted in turn to the bottom frame, which consists of heavy steel beams riveted together. The hinge plates for bottom doors are steel castings riveted to a structural steel frame.

For the usual curved columns, straight cast iron columns of circular hollow section were substituted. Each of these columns is provided with a large flange making the use of a separate base plate unnecessary. The safety tuyere of each cupola is provided with a spout projecting through the shell of the wind-box. It is lined and is provided with the usual safety slide, and is so located that it is always under the eye of the cupola tender. Owing to the size and height required for bottom doors, the cupolas are provided with an operator's platform built up of structural shapes with a checkered plate floor and is provided with substantial hand rails. The Whiting Foundry Equipment Co. has added this size to its standard line and it is designated as No. 12.

ROCKWELL TILTING CRUCIBLE FURNACE.

The Rockwell tilting crucible furnace shown in the accompanying illustrations is designed for melting copper, brass, bronze, aluminum, gold, silver, nickel, iron, steel, etc. The furnace body is constructed of sheet steel, the bottom and top being made of cast iron, flanged and bolted to the steel shell. The steel trunnions are also bolted to the shell and rest on cast iron legs bolted to a cast iron base extending below the floor level. The furnace is tilted by means of the ordinary hand wheel, worm and gear.

The lining consists of fire tile laid in an upper and inner ring, the latter effectually protecting the outer circle of tile. The crucibles used are very much the same as the standards of corresponding numbers except that they are higher. They are made in this way in order that a smaller area of metal in proportion to the weight of metal melted, is exposed to oxidation. As no tongs are used the pots have only a slight bilge.

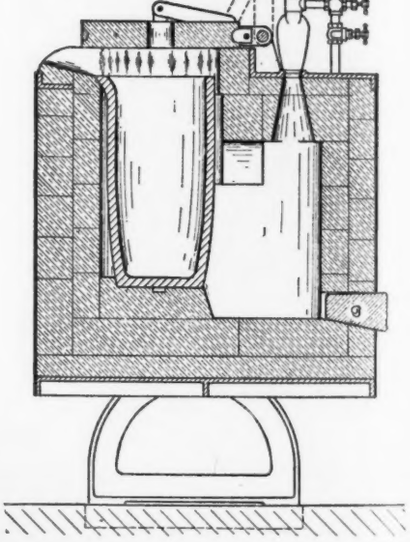


FIG. 3—SECTIONAL ELEVATION OF CRUCIBLE MELTING FURNACE

The top cover is a single fire tile banded with iron to prevent cracking and to support the lifting attachments. It is raised by means of a lever and may be held in any desired position. When open, the hot side is directly upward away from the operator. Unless desired it is not necessary to lift the cover when pouring. This is a distinct advantage in the protection of the molten metal and a matter of much comfort to the operator, as he is fully protected from the heat while pouring.

FIG. 2—FURNACE TILTED FOR SKIMMING

The burner is located at the back of the furnace and is easily accessible.

The furnace is supplied with fuel and air through pipe connections with the opposite trunnion. These connections are not disturbed when tilting, and the burner can be operated with the furnaces in any position and while pouring if desired. Fuel oil at a pressure of five pounds per square inch or higher may be used. Whatever the pressure, it should be uniform. Natural, water or city gas of average pressure can be used, and the furnace for all these fuels is the same except that there is a change in the burner and pipe connections. The furnace in the pouring position is shown in Fig. 1, and in Fig. 2 it is tilted for skimming. In Fig. 3 the furnace is shown in sectional elevation, and in Fig. 4 a sectional plan is shown. This furnace

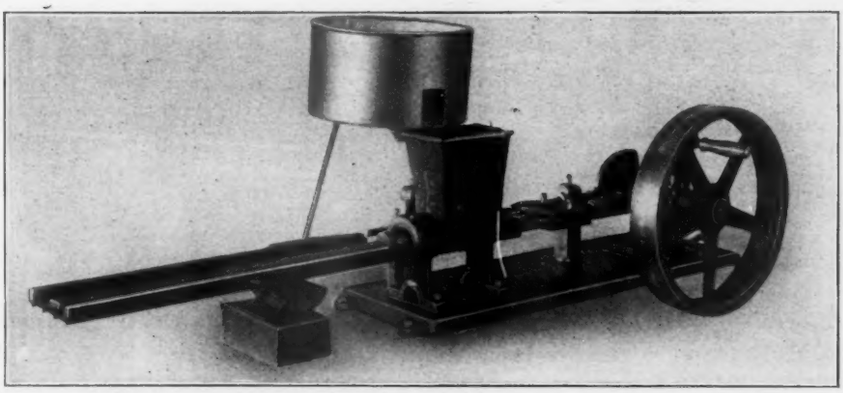


FIG. 1—FRONT OF CORE MAKING MACHINE SHOWING CORE ON CORE PLATE

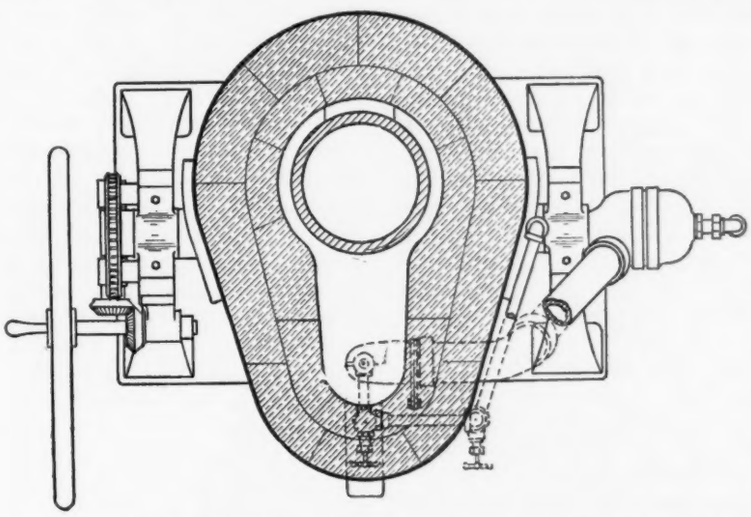


FIG. 4—SECTIONAL PLAN OF CRUCIBLE MELTING FURNACE

is manufactured by the W. S. Rockwell Co., 50 Church streeet, New York City.

A NEW WADSWORTH CORE MACHINE.

An improved plunger feed machine designed to make cores of irregular cross section for which screw feed machines are not adapted, has been designed by George H. Wadsworth of the Falls Rivet & Machine Co., Cuyahoga Falls, O. The dies are made rectangular, oval, or any other shape that may be desired and the plunger corresponds to the die in form. The end of the plunger is cut like a file, only coarser, so as to break up the surface of the sand where the two portions join, and the plunger is likewise provided with one or more vent wires.

When a plunger moves forward through a body of sand that is not confined, it crowds the sand out of the way and only a small portion of it will be forced into the die and pushed forward. To overcome this, the sides of the sand hopper are slotted a short distance above the plunger and a cross-head is arranged which carries a shoe traveling over or above the plunger. This shoe covers the top of the plunger and also extends down across the sides. The plunger is driven forward by an eccentric on the main driving shaft, and it advances and recedes at the same speed, and has a movement in common with all ordinary plunger machines. The shoe over the plunger has a sharp edge which cuts through the sand as it advances. This shoe is driven forward by an eccentric on the main driving shaft connected to the shoe by means of a cross-head and a connection on the side of the machine, not unlike that of the valve gear of an ordinary steam engine. The cam is so designed and adjusted that when the plunger starts forward the shoe is made to travel very much more rapidly than the plunger, and it moves forward and encloses a body of sand in front of the plunger. As this sand cannot escape upward or at the sides, the advancing plunger carries it into the dies, on to the core plate. The cam then returns the shoe before the plunger recedes, so that the sand falls down in front of the plunger as it is withdrawn. The feeding of the sand into the plunger is facilitated by a shaking plate which is operated by the receding shoe. A front view of the machine with a core on the core plate is shown in Fig. 1, while a rear view is shown in Fig. 2. This machine has a capacity for making cores from less than one-eighth inch in thickness up to any desired size within its capacity.

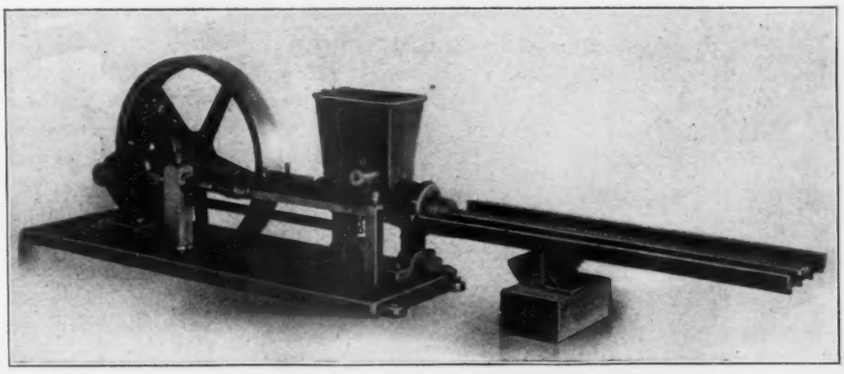
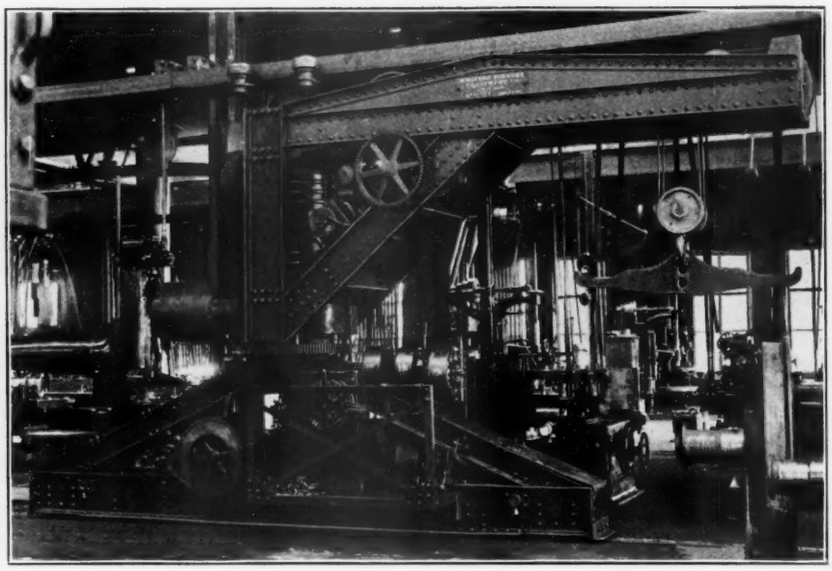


FIG. 2—REAR VIEW OF PLUNGER CORE MACHINE



WHITING ELECTRIC WALKING JIB CRANE

AN ELECTRIC WALKING JIB CRANE.

The accompanying illustration shows an electric walking jib crane, which has recently been completed by the Whiting Foundry Equipment Co., Harvey, Ill., for the Burnside shops of the Illinois Central railroad. The function of this crane is to pick up wheels and axles, distribute them through the shop to wheel lathes, or elsewhere, if desired, and also to place them in storage. The track is laid as close to the column separating the erecting floor from the machine shop as possible, and permits the crane to serve the erecting pits on one side of the track and the wheel lathes on the other.

The crane is of 7 tons capacity, and has an effective radius of 12 feet. It is supported on a single track on the floor and an I-beam track above supports the top of the mast, guide rollers traveling on either flange, as shown. This arrangement requires a minimum of floor space, and also fits in a low head room. The machine is driven by four motors, as follows: A hoist motor of 15 horsepower, hoisting at 16 feet per minute; a trolley rack motor of 2 horsepower, racking the trolley on the jib at 90 feet per minute; a jib rotating motor of 2 horsepower swinging the jib at two revolutions per minute; and a crane trolley motor of 10 horsepower, moving the crane along the floor at 180 feet per minute. The maximum lift of the hook from the rail is 10 feet. The jib is fixed in a horizontal position, and can be neither raised nor lowered.

The load is always under absolute control, and is automatically sustained at all times. The hoist gearing is provided with a double automatic safety brake, so arranged that the load has to be driven down as well as up. The brake attachment consists of two independent brakes, one electrical, the other mechanical. The electrical brake is operated by an electric solenoid in circuit with the hoist motor, and so arranged as to come automatically into action when the electric current is cut off from the motor.

GLENWOOD ROCK-OVER MOLDING MACHINE

GLENWOOD ROCK-OVER MOLDING MACHINE.

The J. W. Paxson Co., Philadelphia, has extended its line of Glenwood rock-over molding machines by the addition of another size, shown in the accompanying illustration, designated as class C, which will take a flask 30 x 48 inches, and is provided with a table having a rise and fall of 10½ inches. In design, the machine is similar to the smaller size which has been on the market for some time, except that it is not portable and it is necessary to provide two small pits 4 inches in diameter and 10 inches deep for a casing in which the upright shafts are located. The evening or leveling device has likewise been improved and provides against all reasonable imperfections in the bottom board, and after adjusting itself to the board will hold it absolutely firm in this position. It has four points of contact with the bottom board, two on each end, which are quickly adjusted to or from the center for either a long or short flask. After the mold has been rolled over, the two small levers, one on each end of this device, should be in their backward position when the table is brought up underneath the mold. This permits the four pistons which come in contact with the bottom board to adjust themselves. Posts provided with spurs are located at each end of this device, and when the operator forces the bottom board upward, one of them will engage the board while the other spurs will be engaged a portion of their length. In addition to preventing the flask from slipping, the spurs give notice to the operator when the table is underneath the flask. The operator then moves the two levers into their innermost position, which permits a wedge to adjust itself under each of the pistons independently, so that if one piston is slightly higher than the other, the

wedge will slip underneath it, holding it in position. Each of the pistons is provided with a spring which holds it against the bottom board and when the levers are moved to their inner-

FIG. 1—CORE BOX ASSEMBLED

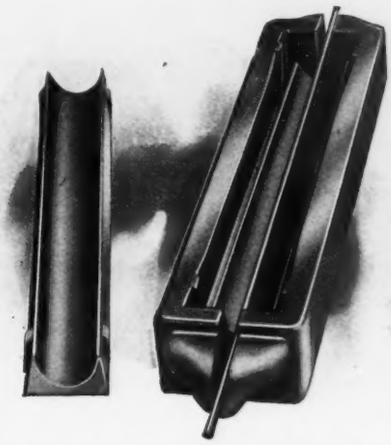


FIG. 2—CORE BOX WITH TOP HALF REMOVED

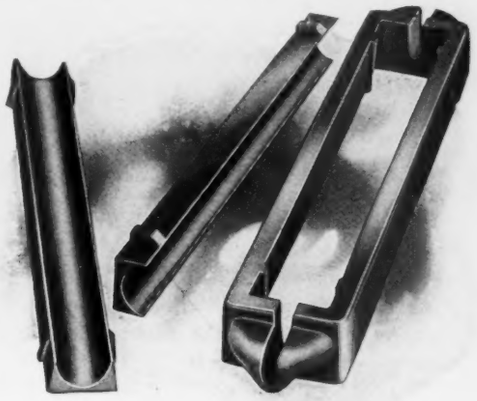


FIG. 3—SECTIONS OF CORE BOX

most position the pistons are locked securely in whatever position they happen to be.

THE HANDY CORE BOX.

An improved core box of novel design for the manufacture of round stock cores and other styles has been placed on the market by the Handy Core Box Co., Brightwood P. O., Springfield, Mass. The accompanying illustrations, showing the core box complete, with the top half removed and with both sections removed from the case, give a clear idea of the simplicity of the device and of its method of operation. The case is of malleable iron and the boxes are of steel. The range of sizes built at present is from ½ to 1½ inches core diameter.

In operation, one-half of the box is laid on a flat bench, the frame is placed over it and filled half full of loose sand. The vent wire is then laid in the vent slots, leaving the wire ends projecting from the frame for easy removal. The core rod is then placed in position, loosely on the sand, and the frame is filled full of loose sand, care being taken not to press or pack the sand. The sand is then struck off level with the frame, the other half of the box is placed in position, pressed into position and given light rappings with a mallet until the top half is level with the frame. To remove the core from the box, each end of the frame is rapped lightly, the vent wire is pulled out, the frame is lifted clear, the two halves of the box are separated and the core is rolled out on the plate.

The process is rapid and accurate, and little skill is required for the successful operation of the box. Good work can be produced from any kind of core sand, and the cores can be made either hard or soft at will, though they are always uniform throughout their length, with no spots to cause cracks or breaks. The device is practically indestructible.

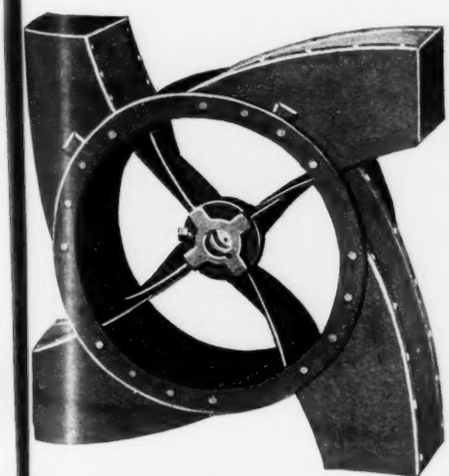


FIG. 1—BLAST WHEEL OF PRESSURE BLOWER

A NEW PRESSURE BLOWER.

A new pressure blower built by the Natural Power Co., St. Louis, is shown in Fig. 2. The unique feature of this blower is the design of the blast wheel, Fig. 1. This is of simple construction built of heavy sheet steel riveted to a steel spider on the lines of a square with an opening at each corner. As distinguished from other types, the working side of each of these four discharges, radiates from the periphery of the inlet circle and not from the center of the shaft. This design of blast wheel allows the air to leave it in a line parallel with the outlet in the housing, increasing the efficiency of the blower. A wheel of much larger diameter can also be used with this design and in consequence the same peripheral speed is obtained with fewer revolutions per minute. It is claimed also that at the slower speed, the blower being distinctly a slow speed machine requiring only from one-half to two-thirds the ordinary number of revolutions to produce the same pressure, an appreciable reduction in the horsepower consumed is obtained. The wheel is balanced on special machinery at high speed to insure perfectly smooth running.

The shaft is of hammered steel of large diameter running in self aligning chain oiling boxes of extra length. The boxes are universal having adjustments in all necessary directions. The housing is made of heavy annealed steel plate or of a cast iron shield. Care is taken to have smooth surfaces to prevent air friction and the joints are all air tight.

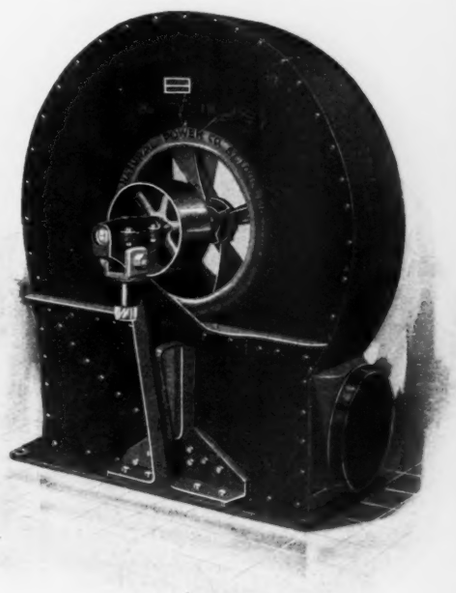


FIG. 2—NATURAL POWER COMPANY'S PRESSURE BLOWER

TRADE NOTES.

The W. S. Rockwell Co., recently incorporated with a capital of $100,000, is now located at 50 Church street, New York City, where it will engage in furnace engineering and will design and build various types of fuel oil appliances. W. S. Rockwell, president of the company, is a well known designer of melting furnaces and other fuel oil apparatus. The other officers include Jos. A. Doyle, vice president; E. S. Long, secretary and treasurer, and Geo. A. Yagle, assistant secretary and treasurer. The new company is already engaged in filling several important contracts. Manufacturing facilities have been arranged and for the present no equipment will be required.

Having discontinued the manufacture of cars a number of years ago, and realizing the importance of a more descriptive name, the Cleveland Crane & Car Co., Wickliffe, O., will hereafter be known and operated as the Cleveland Crane & Engineering Co. The product will be confined to cranes of every description, including traveling, gantrys, mono-rail and grab-bucket handling equipment of various types.

The American Blower Co., Detroit, reports the receipt of a satisfactory volume of business, and a few of the more important orders placed during September follow: Forced draft equipment, Ault & Wiborg, Cincinnati; Hocking Valley R. R., Columbus, O.; W. W. Rice Leather Co., Petoskey, Mich.; Empress Hotel, Victoria, B. C.; White Haven, Pa., Sanitarium; Medfield, Mass., Insane Asylum; Gluck Realty Co., Niagara Falls, N. Y.; and the Garfield, Utah, Smelting Co. Heating and ventilating apparatus—Western State Normal School, Kalamazoo, Mich.; Anglo-Newfoundland Development Co., Grand Falls, Newfoundland; M. E. church, Philadelphia; school at Phillips, Wis.; Western Michigan Asylum, Pontiac, Mich., as well as a number of other large installations.

The E. Killing's Molding Machine Works, Davenport, Iowa, manufacturer of molding machines, report heavy sales of its equipment to foundries located in Pennsylvania, Ohio, Michigan, Indiana, Kansas and Texas.

The new plant which the Wilbraham-Green Blower Co., Philadelphia, is erecting at Pottstown, Pa., will consist of a machine shop 85 x 200 feet, which will be equipped with a 10-ton electric traveling crane running the entire length of the building. The other buildings will consist of a power house, pattern storage building two stories high, and an office building. The company is now moving its machinery and expects to be installed in its new plant between Nov. 1 and 15. This concern is a large manufacturer of blowers for foundry use.

The New Era Mfg. Co., Kalamazoo, Mich., is sending a circular to the foundry trade describing its phosphoro bronze. It is intended for use as a bearing metal subjected to severe service and the formula follows: Copper 80 per cent, tin 10 per cent, lead 8 per cent, metallic phosphoro, 2 per cent. The metallic phosphoro answers a double purpose in this formula, as it not only removes the oxides from the mixture, but also increases the chemical affinity between the different elements, thereby drawing them together in a close fine grained product. It is claimed that 1 per cent of metallic phosphoro added to any of the standard bronze formulas will increase their strength and working qualities from 10 to 15 per cent.

PERSONAL.

R. H. Palmer, formerly superintendent of the foundry of the L. S. & M. S. shops, Elkhart, Ind., has been appointed instructor in foundry practice at the Worcester Polytechnic Institute, Worcester, Mass. Mr. Palmer has had a wide experience in foundry work and his appointment to this position is a deserving recognition of his ability as a foundryman.

Thomas H. Allen has been appointed manager of the foundry and machine departments of the Livermore Foundry & Machine Co., Memphis, Tenn. Mr. Allen was formerly with the Allis-Chalmers Co., Milwaukee.

G. K. Mullen, for the past 10 years sales manager of the Fox Machine Co., Grand Rapids, Mich., has tendered his resignation to take effect Nov. 15, and will at that time engage in business for himself, announcement of which will be made later.

ASBESTOS CORE PLATES.

The Diamond Clamp & Flask Co., Richmond, Ind., manufacturer of core machines and core room equipment, is offering to the foundry trade an asbestos core plate, which has a smooth and dry surface. These plates will not burn, warp or get out of shape, and as they are very light they can be easily handled. Furthermore, they are not nearly as expensive as machined plates. These core plates are made in three sizes, 8 x 8 inches, 12 x 12 inches and 16 x 16 inches.

TRADE PUBLICATIONS.

SMOOTH-ON.—The Smooth-On Mfg. Co., Jersey City, N. J., manufacturer of iron cements and compounds, has issued a 96-page instruction book, which contains detailed information for the use of its various products. The compounds used for castings are designed for smoothing the surface of iron castings, stopping up sand holes and pores in spongy castings, covering up counter-sunk bolts, smoothing over cold short castings and stopping leaks of gasoline or oil. The book is instructive, inasmuch as the method of applying these compounds is also shown by numerous illustrations.

FOUNDRY EQUIPMENT.—The Consolidated Supply Co., Chicago, in a loose-leaf catalog, No. 15, describes air compressors, pneumatic tools, electric trolleys and other devices designed for foundry use.

AIR COMPRESSORS.—The Ingersoll-Rand Co., New York, has published a 50-page catalog which is devoted to a description of small power-driven air compressors. The catalog is handsomely illustrated and contains an instructive chapter on the advantages to be derived from the use of compressed air in the foundry. Several pages are also devoted to air receivers, pressure tanks and pneumatic tools of various kinds, also sand rammers and air hoists.

ANTI-FRICTION METAL.—A. Allan & Sons, New York, has issued the second of a series of bulletins, which when completed will form an extensive descriptive catalog of Allan metal. The use of this anti-friction metal in engine bearings is described in detail and the work is handsomely illustrated.

THERMIT.—The third number of *Reactions*, published by the Goldschmidt Thermit Co., New York, contains an interesting discussion on hard spots in castings, an article on new thermit reactions by Hans Goldschmidt, and a paper by G. W. Kelly on the thermit welding of locomotive frames and other work. This number is handsomely illustrated and shows the wide application of thermit for various purposes.

CRUCIBLE MELTING FURNACES.—The W. S. Rockwell Co., 50 Church street, New York City, has issued an eight-page bulletin describing the Rockwell crucible melting furnace, which is designed for melting copper, brass, bronze, aluminum, silver, gold, nickel, iron, steel, etc. This furnace is of the tilting type and is provided with a cover operated by a lever. Both oil, natural, or artificial gas can be used for fuel.

BRASS FOUNDRY EQUIPMENT.—A special catalog issued by the S. Obermayer Co., Cincinnati, containing 32 pages, is devoted to supplies and equipment for brass, bronze and aluminum foundries. It shows a complete line of brass melting furnaces, crucibles, drying stoves, tongs, flasks, etc., as well as smaller supplies, including riddles, bellows, brushes and shovels. A complete line of sprue cutters, stationary and portable core ovens, metal cutting saws, magnetic separators, core machines, tumbling barrels, oil melting furnaces and water tumbling mills are also included.

FOUNDRY EQUIPMENT.—Whiting Foundry Equipment Co., Harvey, Ill. Catalogs Nos. 43 to 45, fastened with a cloth binder, 6 x 9 inches, and contain 243 pages. They contain many excellent illustrations showing electric and hand power cranes, pneumatic hoists, cupolas, crane ladles and other foundry equipment. The Whiting cupola is described in detail with sectional views and a diagram showing general dimensions.